5-2012

Composted Biosolids as a Soil Cover on Steep Slopes

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I am submitting herewith a thesis written by Justin Lee Fisher entitled "Composted Biosolids as a Soil Cover on Steep Slopes." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Environmental and Soil Sciences.

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Composted Biosolids as a Soil Cover on Steep Slopes

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Justin Lee Fisher
May 2012

Abstract

Municipal sewage disposal and soil erosion control from highly disturbed sites are both large scale issues of environmental concern. Composted biosolids (CBS) and shredded wood have the potential to be applied as soil cover to address both disposal and erosion issues. There is a lack of information on the use of these products on steep slopes, typical of construction sites. The objective of this study was to evaluate the use of CBS for reducing erosion and establishing vegetation on a cherty, slightly compacted, Fullerton Series sub-soil embankment, with an average slope of 46.5 percent. The study was conducted at the Knox County Green Waste Recycling facility in Solway, TN on a spoil pile created during construction of the facility. Twelve plots, each measuring 6.5 meters long by 2.5 meters wide, were used with three replications each of four treatments: bare (uncovered, unseeded), straw mulch, CBS, and a 50/50 mixture of CBS and shredded wood produced on site. Prior to the application of treatments, covered plots were seeded with a standard mixture of seed for erosion control used by the Tennessee Department of Transportation. Total runoff volume and sediment were measured following each rain event, and digital photographs were taken weekly to record vegetation growth from June 24 to October 31. Composted biosolids was as effective as straw at reducing total sediment (95.7 percent and 96.0 percent reductions respectively). The 50/50 mixture achieved the greatest sediment reduction of 96.4 percent. The application of CBS appeared to have the greatest positive impact on establishing vegetation. Vegetation on the straw mulch plots was concentrated on the lower portions likely due to the seed washing down slope following early rain events. The 50/50 treatment reduced total runoff by 69.6 percent, and the CBS treatment by 58.5 percent compared to plots left bare. Total runoff on straw plots was reduced by 47.0 percent compared to plots left bare. The results demonstrate that CBS can be used effectively to reduce soil erosion and establish a vegetative cover on steep slopes of highly disturbed sites, while serving simultaneously as an alternative means of sewage sludge disposal.

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Chapter I

Introduction

Sediment delivery from construction sites and disposal of municipal sewage represent two substantial pollution control challenges faced by industry and government agencies at all levels. Implementing economical and efficient means of sewage sludge disposal, controlling erosion, and establishing vegetation on highly erodible slopes at construction sites benefits both private industry and the general public. As human populations continually grow and expand so do construction activities and sewage disposal to support them, so these challenges are not just perpetual but growing. Innovative strategies must be implemented in order to continue to address these challenges. They may be addressed simultaneously by composting biosolids derived from municipal sewage sludge and utilizing it to control erosion. Various types of materials, both organic and inorganic, have been evaluated as soil cover for sediment runoff control on construction sites. However, research on steep slopes where the most concentrated runoff is produced is limited and composted biosolids have not been evaluated for the capacity to reduce soil erosion and facilitate rapid and stable vegetation establishment on these types of slopes. The benefits of reusing composted biosolids in this manner has the potential to reduce sediment delivery from construction sites and decrease the volume of municipal biosolids that are interred in landfills and sent to incinerators.

According to the *Proceedings of the 6th Federal Interagency Sedimentation Conference* (Bernard et al., 2001), "Sediment continues to be the greatest pollutant of waters of the US by volume." The EPA estimates that 30 percent of sediment that enters the nation's waterways is through natural erosion while the remaining 70 percent is caused by anthropogenic activities and thought to cause 16 billion dollars worth of environmental damage yearly. Types of environmental damage include increased flood potential, loss of habitat, loss of biota, disruptions to the food chain, and increased treatment cost to produce potable water supplies. The most concentrated releases of sediment to the nation's waterways come from construction activities (Mid-America Regional Council, 2011), like those used to build the slope used for this project.

Erosion control is the easiest means to address the sediment pollution problem. Soil erosion occurs through soil particle detachment, transport, and deposition. Erosion control is accomplished by disruption of these three processes. The easiest way to disrupt these processes is to cover the soil. On smooth soil surfaces, such as a graded slope at a construction site, most detachment is caused by the force of raindrop impact (Brady & Weil, 2002). Soil cover will absorb the impact rather than the soil surface, thereby preventing detachment. Once the precipitation rate exceeds the infiltration rate of the soil, runoff begins to occur on slopes. Water flow down slope carries detached particles with it and causes further detachment as energy builds and flow concentrates. A rough soil cover creates a more tortuous path for the flow down slope, thereby diffusing flow energy, slowing the flow, and preventing concentrated flow. This slower flow allows soil particles to more readily settle out of suspension and deposition to occur on site rather than an undesirable location off site. In addition to absorbing raindrop impact, the soil cover materials used in this project created a rougher surface over a relatively smooth graded slope.

Soil covers, as with all erosion controls, represent an additional cost of construction. As this does not directly contribute to the completion of the construction project, it is desirable to keep this cost to a minimum. Treatments such as rock armor and hydro-seeding can be too financially burdensome to a project. Sewage sludge and woody wastes represent a pool of available materials, with little to no cost attached because they must be disposed of somehow. These materials can be easily made suitable for this purpose. The University of Nebraska Cooperative Extension in *NebGuide* G79-464-A (Chesnin, 1996) presents the case for composting sewage sludge from municipalities and recycling them. It points out that separating and composting the solids (biosolids), eliminates most problems associated with direct application of sewage slurries. These include handling and transporting large quantities of water, seasonal restrictions due to freezing and soil moisture fluctuations, and the erosion potential of applying such large volumes of water on slopes. The composting process leaves behind very few to no live seeds or foul odors and renders the material unattractive to insects. This process begins by mixing the sewage sludge slurry with drying and bulking agents. The CBS used in this project was a mixture of sewage sludge slurry from the Knoxville Utilities Board (KUB) and shredded woody wastes produced at the Knox County Green Waste Recycling Center as the drying and bulking agent. Wood wastes at the recycling center come from maintenance work performed by the municipality, individual property owners, and local businesses that perform clearing work. At around 20 percent moisture content the resulting compost is easily spread with various implements or even by hand. This process essentially turns two waste products into a material that is useful in different applications.

At the time of this study, Knoxville County, TN had a surplus of this type of composted material available for testing at their Knox County Green Waste Recycling Facility in Solway, a suburb between Knoxville and Oak Ridge, in Tennessee. The site also had a steep slope, typical of large scale construction sites, making it an ideal location for the experiment. The steep slope (46.5 percent) was comprised of spoil generated during the construction of the facility and was slightly compacted by bulldozing. The effectiveness of the composted biosolids (CBS) treatment was evaluated along with the performance of composted biosolids mixed with shredded wood waste on a one to one volumetric basis, and against straw which is commonly used as a soil cover. The research conducted with the composted material produced by the recycling facility at the highly disturbed site provides insight into the materials applicability for erosion control.

All plots except for the control plots (left bare) were seeded with a standard seed mixture used by TDOT (1995) for establishing vegetation on slopes left bare from construction activities. Digital photographs were evaluated to compare the establishment of vegetation, a more permanent erosion control. *Sigma Scan Pro* color analysis software was used in an attempt to quantify green cover.

The objectives of this study were twofold: 1) to evaluate the effectiveness of composted biosolids and composted biosolids mixed with shredded wood wastes for use as a soil cover to reduce erosion on a steep highly disturbed slope, and 2) to evaluate the effectiveness of composted biosolids and composted biosolids mixed with shredded wood wastes for establishing a vegetative cover on these types of slopes, both compared to the more common erosion control treatment of spreading straw.

Chapter II

Literature Review

Sewage Sludge and Biosolids

Approximately 45 billion gallons of sewage laden wastewater goes to municipal wastewater plants for treatment in the US every day (National Biosolids Partnership - Biosolids.org). The treatment and subsequent release of all this water back into the environment leaves behind a quantity of sewage sludge that must be handled in an environmentally responsible way. "The new term **"***biosolids***"** is becoming more common as a replacement for the term "*sewage sludge*" because it is thought to more accurately reflect the beneficial characteristics inherent in sewage sludge" (USEPA, 1994). Biosolids are treated sewage sludge that can only be used in accordance with the Title 40 of the Code of Federal Regulations (CFR) Part 503 (USEPA, 2010). The Part 503 rule was created to protect public health and the environment from possible adverse effects from certain hazardous substances that may be present in biosolids. According to the United States Environmental Protection Agency (USEPA) approximately 50 percent of all biosolids produced in the US are reused by being land applied (USEPA, 2010). This implies that approximately 50 percent of biosolids in the US end up land-filled or incinerated for various reasons including the quantity of hazardous constituents rendering them unsuitable for land application, public aversion to the idea, and sometimes because the economics and logistics of a particular circumstance have yet to be addressed or resolved. These disposal methods incur a higher cost than land application. Due to the fact these materials were derived in large part from fecal matter, pathogen transfer is a major concern when considering land application of these products. Pathogens such as Salmonella as well as other bacteria and viruses present a danger to human health and are found in sewage sludge. Subpart D of the Part 503 rule sets requirements for reducing pathogen transfer as well as vector attraction for sewage sludge and biosolids derived from it before they can be land applied. If pathogens are reduced to non-detectable levels in biosolids they are considered "Class A" and can be used without access restrictions. If pathogens are significantly reduced to certain benchmarks specified in the 503 rule they are considered "Class B" and may be land applied provided site access is restricted to specified guidelines while natural attenuation further reduces pathogens. Composting is considered a process to further reduce pathogens (PFRP) and composted biosolids are considered "Class A" if the composting processes specified in the 503 rule are used. Sewage sludge and derived biosolids, produced in various forms, have been studied in a myriad of situations to assess the potential benefits and possible risks associated with their use.

Ippolito et al. (2010) studied both short and long term soil quality effects from both a single and a double composted biosolids application on semi-arid grassland soils and vegetation in Colorado. There was an 11 year time period between applications for the plots that were twice treated with biosolids. Soils and vegetation were evaluated in the second and third years following the second application. As expected, increased rates of biosolid application resulted in increased soil organic matter content and extractable metal content of the vegetation. However, even the double application at the highest application rate (30 Mg/ha) revealed no significant environmental risk, as the metals content did not exceed that considered hazardous for livestock grazing by the EPA.

In a study by Cox et al. (2001), composted animal manure was evaluated against coal ash and straw amendments for restoring overall soil quality of an eroded Palouse soil in eastern Washington. Compost was incorporated into 4.9 by 30.5 meter field plots using a moldboard plow. This study found compost to have the greatest positive impact on improving overall soil quality by increasing aggregate stability and decreasing soil impedance, a measure of resistance to force. Soil bulk density was also most greatly affected by the compost treatment. In soil samples evaluated during the spring, following treatments applied the previous fall, all samples had a much greater increase in soil bulk density (16.2-29.9 percent) than soil amended with compost, which had only a slight increase of 3.6 percent.

Composted sewage sludge has been recommended for use in the production and maintenance of ornamental plants by the University of Maryland Cooperative Extension (MCE). Fact Sheet 501, by Francis R. Gouin (1992) of the MCE describes three different types of composted sewage sludge. These are lime dewatered sludge and polymer dewatered sludge combined with organic materials such as wood chips, and polymer dewatered sludge combined with processed garbage (sacked household garbage). Lime dewatered composted sewage sludge is slightly basic and thus may be desirable in situations where reduced soil acidity is desired. Polymer dewatered CBS can be quite acidic to near neutral depending on the bulking agent used, so the pH may need to be adjusted with lime or sulfur depending on the application. CBS made with processed garbage tends to be near neutral and MCE reports that plants respond just as well to this type of CBS as they do to CBS made with wood chips. The use of sacked garbage in the composting process represents a greater expenditure of energy and effort due the non-organic constituents that need to be removed in the process but also redirects a portion of the household garbage waste stream.

Rutgers Cooperative Extension also published a series of Fact Sheets regarding biosolids. FS953, by Krogman and Boyles (2000) described different types and uses of sewage sludge and biosolids. They reported CBS to be Class A in most cases, which meant that pathogens have been reduced to below detectable amounts whereas liquid sewage sludge is reported as class B indicating pathogens were still present in detectable amounts but had been reduced to levels that USEPA does not consider a threat to public health or the environment as long as access to the application area is restricted (USEPA, 1994). Composting may be used as a final treatment process for biosolids to further reduce any remaining pathogens (PFRP) in liquid biosolids. Advanced alkaline stabilized biosolids, which use lime for stabilization and disinfection by raising the pH above 12 for a period of time, are relatively dry and meet Class A requirements. These may be further processed through composting with other organic waste materials to produce a more stable material. Pelletized biosolids are rendered Class A through the high temperatures used to process it. This represents a significant energy expenditure and cost of production. The alkaline materials that must be procured for advanced alkaline stabilization also represent an additional cost of production. Because composting uses natural biological processes and bulking agents are readily available at disposal sites, it is likely the most economical means of final treatment of biosolids in most situations.

Biosolids as Runoff and Erosion Control

Alternative uses for various organic waste products have been considered or evaluated by many government agencies and research institutions. Erosion abatement represents a significant portion of the studies conducted. Transportation Departments in several states have evaluated composts and mulches of organic waste products as erosion control tools in efforts to divert organic wastes towards more beneficial and economical reuse (Storey et al., 1996; Goldstein, 2000; Demars et al., 2000), as they are often among the largest creators of increased erosion potential through construction activities. Composts and mulches have been found to be effective erosion control tools in states where evaluations have been conducted. Most green waste products evaluated thus far have been comprised of greater amounts of mulch than compost, likely due to the lesser amount of time and processing involved. Compost, however, can be more effective at reducing erosion and establishing vegetative cover on embankments typical of highway construction than hydromulching due to its ability to improve soil structure and fertility (USEPA, 1997).

The erosion reducing potential of compost exists not merely in the form of a soil cover, but also as a soil enhancer. It has the capacity to improve soil structure and stability, and hasten the establishment of a healthy vegetative cover, a more permanent means of erosion control. "Compost has been viewed as a valuable soil amendment for centuries." (USEPA, 1997). Composted biosolids derived from sewage sludge, however, have only been evaluated for erosion control in the previous few years, as the need for alternative means of sewage sludge disposal has increased and the hazards associated with biosolids have decreased.

Municipal solid waste compost has been evaluated as a re-vegetation tool for mine tailings. A study by Norland and Veith (1994) used municipal waste compost of different ages and application rates with three fertilizer rates to progressively increase vegetative cover of coarse-grained iron ore mine tailings over a period of four years. Compost was applied as a soil amendment to 2.5 by 4 meter test plots at mine tailing basin sites in Minnesota. At one site, ninety percent vegetation coverage required by state law was achieved with seven of 16 treatment combinations of compost and fertilizer over this four year period. The others were all within 10 percent of the requirement. At the other site 23 of 28 treatment combinations produced the required coverage within four years. With more time all treatment combinations were expected to produce the required coverage.

A study conducted by Guerrero et al. (2001) evaluated the effects of municipal solid waste compost on burned forest soil located in Valencia Spain. The composted material was incorporated into 10 by 10 meter plots. This study found the application of compost improved vegetation recovery from 10.2 to 53 percent on a percent coverage basis. Total organic carbon (TOC), nitrogen, and potassium levels all increased as a result of the compost treatment with greater increases occurring with greater rates of application. TOC also increased with time. It was concluded that the use of composted municipal waste was a cost effective and ecologically safe way to reclaim burned forest soils.

Composted biosolids have been proven effective at more rapidly establishing vegetation on forest soils following a wildfire. Research conducted by Meyer et al. (2004) evaluated soil rehabilitation and vegetative cover on plots receiving a single treatment, at five application rates, of composted biosolids, against plots left untreated, at a severely burned site near Buffalo Creek Colorado. Soil carbon and nitrogen levels were measured along with plant biomass for four years following the treatments. Soil carbon and nitrogen levels were found to increase linearly with biosolids application rate in the first year after treatment, but decrease without a trend in subsequent years. Plant biomass was found to increase linearly with greater amounts of biosolids applied in all years. Increased soil carbon and nitrogen and increased plant biomass effectively increase soil stability and soil cover, thereby reducing soil erosion potential.

A laboratory study by Bresson et al. (2001) evaluated surface structure stabilization by composted municipal solid waste and the resulting effect on runoff and erosion. Composted municipal solid waste was mixed with a silt loam soil from the northern Paris basin at a rate of 15 g/kg and packed in runoff trays. Sediment concentration in runoff was reduced from 36.4 to 11 grams per liter after one hour of simulated rainfall applied at a rate of 19 mm per hour. As part of the same study, surface crusting was monitored in separate microstructure boxes and characterized using diagnostic features suggested by Vlentin and Bresson (1998). A polarizing microscope and time-lapse photography were used for this. It was concluded that this municipal waste compost treatment significantly reduced soil surface crusting and soil erosion.

An upper limit of benefit to the application of biosolids for erosion reduction was found in research conducted by Moffet et al (2005). The effects of 30 minute simulated rainstorms on desert grass and shrub land were evaluated for three biosolids application rates. The difference in erosion reduction between application rates of 34 and 90 Mg/ha was not found to be significant, whereas the difference between application rates of 0, 7, and 34 Mg/ha were found to be significant. This study also demonstrated that the application of biosolids was more effective in the winter season than in the summer season in the Chihuahuan Desert Grassland where this study was conducted. This observation was attributed to the greater moisture content of the biosolids applied in the winter season. During that time of year less drying out would occur between processing and application, and after application. The link between moisture content and effectiveness at reducing erosion was stated to be unclear, but likely attributable to greater stability of the soil and the biosolids due to more consistent moisture conditions than during the summer when drying would be more rapid and thorough, decreasing stability.

Simulated rainfall was also used on 10 to 12 percent slopes by Martinez et al. (2002) near Madrid, Spain to compare the effects biosolids and composted municipal solid waste had on runoff from soils in a degraded semi-arid ecosystem when applied at 80 Mg/ha to 3m by 20m plots. The tests conducted three and four years after application of the materials found that biosolids treatment reduced the quantity of runoff water and the amount of sediment it contained more than composted municipal solid waste producing sediment yields of 34.40 and 51.26 g/m^2 respectively in the third year and 1.04 and 56.36 g/m^2 respectively in the fourth year.

Ojeda et al. (2003) evaluated runoff and sediment loss from plots treated with sewage sludge in three different forms. Fresh, composted, and thermally dried sewage sludge was applied at rates sufficient to equal 10t/ha of dry matter of the sewage sludge. In a single application to soils on a 16 percent slope, thermally dried sewage sludge proved to be the most effective at reducing runoff and sediment loss. Plots treated with CBS in this study actually produced more runoff than the control plots. The CBS in this study was produced by mixing sewage sludge with pinewood splinters. The material is believed to have developed a level of hydrophobicity as it dried out. The properties of the materials used in the composting process need to be carefully considered if the finished product is to be used for erosion control, to achieve the greatest possible reductions to runoff and sediment control. In a few instances the collection system used in this experiment was insufficient for the amount of runoff produced, similar to the early part of the study presented in this paper.

Steep Highly Erodible Slopes

As slope steepness increases so does soil erosion. Steep slopes at construction sites are often comprised of spoil or fill material at the surface or sometimes in their entirety. Their erodibility is often further increased by the loss of structural stability incurred through the grading and earth moving operations that created them. Steepness combined with decreased stability makes it particularly challenging to control erosion, conduct research, or simply traverse.

Buchanan et al. (2002) studied the use of woodchips as a soil cover for steep slopes. In this study woodchips produced from maintenance of urban forests were applied at 80 percent soil coverage. It was determined that the use of woodchips for soil cover on 55 percent slopes could reduce soil erosion by up to 86 percent. Considering the evidence, it is feasible that composted biosolids would produce similar or even better results in a similar situation. This research served as the principal reference for this project.

Other erosion research with steep slopes has demonstrated that geotextiles used as erosion control perform similar to mulch. Palm leaf geo-textiles were evaluated by Smets et al. (2006) for their ability to reduce run-off and inter-rill erosion on both medium and steep slopes, using laboratory erosion plots and simulated rainfall. These are simply woven nets made from palm leaves. Both palm leaf geo-textiles evaluated in this study had similar cover percentages (42percent and 43percent) and were found to significantly increase the infiltration rate and decrease runoff volume and inter-rill soil loss of the sandy loam soil used in this experiment.

The effects of controlled burns for wildfire prevention on vegetation established for erosion control on steep slopes was studied by Gyasi-Agyei (2004). On steep slopes (30 – 35 percent) along railway corridors in Australia, the controlled burning of vegetation increased the rate of soil loss by up to 17 times compared to a 100 percent grass cover treatment left intact during the first season after the burn. The increase in soil loss was only nine fold on burned slopes that had been amended with rock ballast. Over the three and a half year course of the experiment, slopes with vegetation left intact reduced soil loss by 95 percent, while those that underwent controlled burning still reduced soil loss by 90 percent. This experiment suggests that controlled burning has manageable effects on erosion control measures, but indicates vegetation needs to be re-established as quickly as possible for maximum effectiveness on steep slopes.

The effect of placed rock armor, versus that of rock armor randomly dumped, on erosion by flow down steep slopes was evaluated by Pierson et al. (2008). Three sizes of rock were evaluated and each size class was sorted to 2.3 percent uniformity for increased stability. This study, conducted in a test flume, found that by placing rock to maximize bulk density and minimize between rock porosity that the flow at which failure occurs increases by 30 percent and rock mass per unit area increases by 35 percent over that of the same rock randomly dumped on slope. This type of erosion control is used in coastal breakwater areas which must consider costs associated with repairing these controls when damaged by storms. The study illustrates that constructing more tortuous flow paths inhibits the build-up of energy as down slope flow occurs, decreasing the likely hood of control failure and hence the incidence of damage needing repair.

Hydro-seeding re-vegetation is a common technique for erosion control on steep slopes. A study conducted by Montoro et al. (2000) evaluated three such techniques on a 40 percent anthropic slope in Cordoba, Spain. The site used in this study is similar to the one used for the research presented here, in that the slopes were artificially created at a disposal site. However, the sandy soils and Mediterranean climate of the area are very different. Only 15 runoff producing events were recorded over the two year course of this study, compared to 13 observed in four months for the research presented here. Three surface covers with hydro-seeding were evaluated against a bare treatment without hydro-seeding on 10m x 3m plots. The cover treatments were vegetal mulch, humic acids, and a combination of vegetal mulch and humic acids. The combination of vegetal mulch and humic acids was found to have the greatest ability to reduce both runoff and sediment loss. All cover treatments reduced sediment loss by more than 94 percent. The superior performance of the combination treatment is attributed to the combination of shielding by the mulch and an improvement in soil structure caused by the humic acids, which happen to be a major constituent of compost.

Composted biosolids have had positive impacts in the experiments discussed above when applied to soil. However, the use of composted biosolids as a soil cover on steep, highly erodible slopes has yet to be evaluated. Most research involving soil loss and biosolids has been conducted in agricultural settings that are more gently sloping than those typical of large scale construction settings. The usefulness of other organic waste products as soil cover on steep slopes has been studied to a limited extent with positive results. The research discussed here also indicates that composted biosolids are safe and effective at reestablishing vegetation, an important step for reducing erosion and runoff over longer periods of time.

The main objective of this study was to evaluate if CBS and CBS mixed with shredded wood waste can be used effectively to reduce erosion and runoff on steep highly erodible slopes. Evaluating the use of composted municipal sewage sludge as a soil cover and vegetation enhancer on steep, highly erodible slopes will provide more evidence of the benefits of reusing these products as erosion controls and soil amendments. The ultimate goal of this experiment was to provide evidence that composted biosolids products can be used just as effectively to control erosion on steep highly erodible slopes as common straw treatments currently employed.

Chapter III

Materials and Methods

Site

This experiment was conducted on a highly disturbed slope at the Knox County Green Waste Recycling Facility in Solway, TN. This facility is directly across the Clinch River from the TVA Bull Run Steam Plant which was visible from the top of the embankment. A NOAA precipitation measuring station is deployed at the steam plant and was relied upon to indicate when precipitation likely fell at the experiment site and samples would likely need collection. All facilities and equipment were provided by The University of Tennessee and The Knox County Green Waste Recycling Facility. The Knox County Green Waste Recycling Facility works in cooperation with the Knoxville Utilities Board (KUB).

Plot Design and Construction

Twelve runoff analysis plots were constructed on a steep embankment at the north end of the compound (See Figure 1). The embankment was largely comprised of spoil generated during the construction of the facility and was very cherty. Many pieces of large debris including concrete and cinder blocks were removed prior to the preparation of the slope. The embankment was smoothed and slightly compacted by Earthworks, Inc. using a Bulldozer. Prior to preparation the embankment had slopes ranging from approximately 25 to 65 percent. The upper portion of the embankment (about three meters) had slopes ranging from 25 to 35 percent while the remainder of the embankment ranged from 50 to 65 percent. The embankment was approximately 50 meters across its crest by approximately 12 to 14 meters from the crest to toe of the slope. The steeper portion of the slope was graded to an average slope of 46.5 percent as determined by a topographic survey using high resolution survey equipment. Since this experiment was implemented to study steep slopes it was decided not to use the upper portion of this slope because it was not as steep and to avoid effects that might have been caused by the convexity at the slope break. The lower portion of the slope was cut and graded level to provide a flat base to set up the flow divider systems, and to provide for sufficient fall from the experimental plot to the flow divider system. This left a vertical cut slope at the base of the embankment. The collection triangles at the base of the experimental plots terminated at the edge of this cut slope where they fed into the flow divider system.

Figure 1 – View of the experiment site. The piles of CBS and shredded wood waste can be seen on the left with the Knox County Green Waste Recycling Facility in the background.

The erosion plots for this experiment measured 6.5 meters long by 2.5 meters wide and were laid out using a total station surveying instrument. The elevations taken at the plot corners were used to calculate the slope of each plot and the average slope of the embankment. The plot size was dictated by the area available for the experiment and the decision to use only the steeper portion. A collection triangle was constructed at the base of each plot using 10 mil black plastic and pressure treated timbers by rolling the plastic around the timbers to form two sides of the triangle and staking them firmly into the ground (See Figure 2). At the upper side of the collection triangle, along the base of the erosion plot, a trench was excavated to insert and backfill the edge of the plastic, forming a seamless transition between the plot and the collection triangle. At the tip of the collection triangles, the flap of plastic left by rolling it around the timbers was trimmed neatly to stuff into the pipe leading to the flow divider system and prevent any leakage between the collection triangle and the pipe. The pipes were secured to the collection triangles using strap metal and screws. The plot layout was designed so that there was enough area between the plots for the construction of a 0.5m berm to fully separate the individual plots. The berms were completely covered with the shredded wood waste readily available at the site to prevent them from eroding and to create identical edges along the sides of the plots. The berms were built over three inch PVC pipes that were placed between the plots to carry runoff drainage from above the plots to the area below the plots in an effort to alleviate the impacts runoff from above the plots would have on the berms separating the plots. Debris traps were placed on the upper ends of the drainage pipes to keep out large debris. Stakes were driven on the lower ends to hold the pipes in place on the steep slope. In the area above the plots a diversion triangle was constructed above each plot to divert runoff from upslope around the plots and into the drainage system constructed in the berms. The diversion triangles were constructed of commonly available hammer-in plastic garden edging. This material consists of black plastic tiles that lock together with a pointed end on each tile. The same number of edging tiles was used for each diverter to make the area they encompassed above the plots approximately equal. This area was covered as well and contributed to the amount of runoff collected from each plot, but was of minimal concern because this study was conducted for comparison's sake and their equal size prevented any disproportionate contribution to an individual plot.

Figure 2 – View of plots (plot 12 nearest) just before clearing of vegetation and application of cover treatments showing the collection triangles down slope and the diversion triangles up slope.

Collection System

The flow divider system, built on five gallon buckets, was developed by the University of Tennessee Department of Biosystems Engineering and Soil Science. The entire system was described in detail by Pinson et al., (2004). It has been previously deployed in other erosion studies, such as Buchanan et al., (2002) and was readily available in the department. In previous studies the flow divider system was set up on more elaborate platforms with more substantial protective coverings. For this study economy was a primary objective, making the previous deployment measures undesirable. All that is really necessary for the system to function properly is the ability to keep it perfectly level and sheltered from precipitation. The system is leveled using adjustment bolts in the corners of the triangular holders the collection buckets are set upon. The amount of adjustment is dictated by the length of the bolts, so all that is needed to ensure the ability to keep the dividers level is a flat surface that is close to level, and hard enough to provide rigid base for the adjustment bolts to rest upon. Since the base of the slope was cut close to level with a bulldozer, a simple rigid base for bolt adjustment would fulfill the last requirement. The College of Agriculture has many common wooden pallets on hand as well as scrap lumber. These were utilized to construct the rigid base of the system (See Figure 3). Pilings were built using scrap lumber to raise the first flow divider to a height sufficient that flow from it to the second divider would travel freely. Scrap pieces of two inch by four inch lumber stacked three layers high was sufficient to reach this height. The triangular holder for the secondary flow dividers were placed directly on the pallets. Small recesses were drilled where the adjustment bolts would contact the pilings and the pallets to hold the adjustment triangles in place. The final bucket in the system does not need to be perfectly level (only secure) and was simply seated firmly in the mud. Once samples were removed, all buckets were thoroughly cleaned inside and out prior to redeployment. Shelter for the flow divider system was provided by common heavy duty tarps. These were secured to the ground using steel rebar with a bent end as pins.

Figure 3 – Flow Divider System on Plot 12 after almost four months in service.

Treatments and Application

The plots received four treatments with each treatment replicated three times. Treatments were arranged in a randomized block design (RBD) blocked on slope percentage. The treatments were comprised of: 1) a control plot of bare soil, 2) at least 80 percent coverage using composted biosolids provided by KUB, 3) at least 80 percent coverage of a 50/50 mixture of the composted biosolids material additional shredded wood waste, 4) and at least 80 percent coverage using straw (See Figure 4). The plots that received a cover treatment were first seeded with TDOT group “A” seed mixture as specified in section 918.14 Construction Details for TDOT projects (1995). The seed was spread at a rate of 5 kilograms per 100 square meters as specified in section 801.07 Construction Details for TDOT projects (TDOT, 1995). No fertilizer was used in this study because it was of interest how the treatments alone would influence vegetative establishment. TDOT does not have a written standard treatment for erosion control and vegetation establishment. Erosion control measures are left to the discretion of the project engineer. It is a common practice to use biodegradable netting to hold the straw in place. This practice was not used in this project. The seed mixture was applied by hand to ensure that all the seed allotted for each plot landed on the plot when applied. A broadcast seed spreader would have likely applied some portion of the seed over the edges of the plots and a drop spreader seemed impractical considering the steepness and roughness of the slope. Cover treatments were also applied by hand using shovels and pitch forks. The 50/50 mixture of CBS and additional shredded wood was mixed volumetrically in a wheel barrow by placing an equal number of shovel scoops of each in the wheel barrow and mixing it thoroughly. For the plots that received a cover treatment, at least 80 percent coverage was desired. Coverage was measured using the same measuring device constructed by Buchanan et al., (2002). The device consists of a one meter square frame with one centimeter square beads strung on a one decimeter grid within the frame. The number of beads lying in full on cover material was counted. If less than 80 percent of the beads were fully on cover material, additional cover was added and additional counts taken until each plot that received a cover treatment had at least 80 percent coverage. A count was taken on the upper and lower portion of each plot by placing the measuring device randomly by tossing it onto these areas. The average of the upper and lower counts was considered the percent coverage of the particular plot. The topographic plot data is presented in Table 1.

Figure 4 – View of plots (left to right) 12 through 9 shortly after construction was complete.

Table 1. Slope and Coverage Determinations for Experiment Plots

Plot	Treatment	Percent Cover		Corner	Elev.(ft)	L Relief	R Relief	L Slope	R Slope	Slope	Block
P1	Straw	Top		LL	-5.07	11.78	11.78	47.87%	47.87%	47.87%	B
		89	Avg.	LR	-4.43						
		Bottom	88.5	UL	6.71						
		88		UR	7.35						
P2	50/50	Top		LL	-4.48	11.19	11.22	45.47%	45.59%	45.53%	A
		86	Avg.	LR	-3.87						
		Bottom	82	UL	6.71						
		78		UR	7.35						
P3	CMW	Top		LL	-3.82	11.69	11.74	47.50%	47.70%	47.60%	B
		86	Avg.	LR	-3.33						
		Bottom	83.5	UL	7.87						
		81		UR	8.41						
P4	CMW	Top		LL	-3.20	11.75	11.82	47.74%	48.03%	47.89%	C
		80	Avg.	LR	-2.71						
		Bottom	81	UL	8.55						
		82		UR	9.11						
P5	Control	Top		LL	-2.36	11.57	11.48	47.01%	46.65%	46.83%	B
		0	Avg.	LR	-1.77						
		Bottom	0	UL	9.21						
		0		UR	9.71						
P6	50/50	Top		LL	-1.75	11.81	12.29	47.99%	49.94%	48.96%	C
		86	Avg.	LR	-1.33						
		Bottom	82.5	UL	10.06						
		79		UR	10.96						
P7	Straw	Top		LL	-1.28	12.33	11.72	50.10%	47.62%	48.86%	C
		88	Avg.	LR	-0.70						
		Bottom	89	UL	11.05						
		90		UR	11.02						
P8	Control	Top		LL	-0.70	12.02	11.90	48.84%	48.35%	48.60%	C
		0	Avg.	LR	-1.58						
		Bottom	0	UL	11.32						
		0		UR	10.32						
P9	50/50	Top		LL	-2.79	11.59	11.78	47.09%	47.87%	47.48%	B
		88	Avg.	LR	-2.46						
		Bottom	86.5	UL	8.80						
		85		UR	9.32						
P10	Straw	Top		LL	-2.90	10.76	11.53	43.72%	46.85%	45.29%	A
		88	Avg.	LR	-2.90						
		Bottom	82	UL	7.86						
		76		UR	8.63						
P11	Control	Top		LL	-4.05	10.10	11.26	41.04%	45.75%	43.40%	A
		0	Avg.	LR	-3.60						
		Bottom	0	UL	6.05						
		0		UR	7.66						
P12	CMW	Top		LL	-4.70	9.51	10.03	38.64%	40.76%	39.70%	A
		87	Avg.	LR	-4.17						
		Bottom	83	UL	4.81						
		79		UR	5.86						

Block – Randomized Block Design blocked on slope percentage
LL denotes Lower Left, LR Lower Right, UL Upper Left, and UR Upper Right plot corners, facing the slope from the bottom.

The elevation shots for the right side of plot eight (highlighted) were recorded as errors by the total station instrument. This was not discovered until the data was transferred to a computer. It was decided to estimate these elevations by calculating the average of the two nearest measured points to each of the two points recorded as error and calculate a slope percentage for the right side of plot eight from these estimates. The lower left elevations for plot eight and plot nine were used to estimate and elevation for the lower right corner of plot eight. The same method was used to estimate the upper right corner of plot eight.

Precipitation Measurement

Precipitation was measured using a tipping bucket rain gage and recorded using a CR500 CSI data logger. Precipitation amounts were recorded by the data logger every 15 minutes. Shorter time intervals are desirable for precision but storage capacity of the data logger available was a concern at the time. A PDA was used to collect data from the data logger and transport it back to university facilities where precipitation intensity was calculated using spreadsheets, and a 30-minute Erosivity Index value was generated. The 30-minute Erosivity Index was generated by summing the amount of energy calculated for each 15 minute interval in a rain event and multiplying this total by greatest 30 minute intensity observed during that rain event (Renard et al., 1997). The rain gage was placed at the top of the embankment equidistant from each end. A manual 4-inch rain gage was also deployed and monitored.

Sampling

Following each rainfall event, the volume of runoff was determined by measuring the depth of runoff in the collection buckets, calculating the amount that flowed through the system, and subtracting the amount of precipitation that fell directly on the collection triangles. The buckets were then secured with a screw on lid and transported to university facilities where they were analyzed for sediment load. Clean buckets were placed in the flow divider system, leveled, and covered before hauling samples to the lab. Once samples reached the lab they were analyzed as follows.

Sediment Analysis

When samples were brought to the lab, the sample containers (buckets) were arranged in numerical order for convenience and analyzed in the following manner. The screw top lids were loosened and the material in the buckets was then allowed settle for at least 24 hours until the supernatant was clear. The supernatant was then siphoned from each bucket to just above the top of the sediment taking care not to siphon off any sediment. Drying pans were then tared and labeled for each bucket of sediment. Aluminum pans were used as drying pans. Sediment from each bucket was then transferred to the appropriate drying pan and rinsed well to ensure that all sediment was transferred. Multiple drying pans were often necessary for a single bucket of sediment, as the amount of sediment collected was often enough to fill or nearly fill the primary bucket from each plot. The samples were then dried at 105 degrees centigrade for a minimum of 48 hours. The largest sediment samples required at least this much time. Samples were weighed immediately upon removal from the oven and the masses were recorded. The tared weights of drying pans were then subtracted from these weights to determine the mass of sediment collected in each bucket.

Sediment Yield Calculation

The total mass of sediment that passed through each collection system was calculated as described by Pinson et al., (2004). However, due to an analysis error, sediment mass data for the first five sampling events had to be estimated. Sediment from the primary and secondary collection buckets was errantly combined before analysis. In an attempt to salvage some insight from the effort a back calculation was used to generate an estimated sediment load from the first five sampling events. The estimate was made using the masses collected in the primary and secondary collection buckets for sampling events six through ten. Sampling event 11 was not used to generate the estimating percentage because no runoff was collected in the secondary flow divider for this sampling event. For each plot in each sampling event, the mass collected in the secondary collection bucket was divided by the sum of the masses collected in the primary and secondary collection buckets. The resulting five percentages from each plot were used to produce an average percentage for each plot. This average percentage for each plot was applied back to the known total masses collected from each plot in the first five sampling events to produce an estimate of the mass collected in the secondary collection bucket in each event. This estimated mass was subtracted from the known total mass collected from each plot to produce an estimate of the mass collected in the primary collection bucket. The resulting estimated masses collected were then used to calculate sediment yield as described by Pinson et al., (2004).

Vegetative Cover Evaluation

Vegetative cover and growth were recorded with a series of digital images captured with a digital camera. Images were captured of each plot during each sampling event and sometimes between sampling events, from the same standing position each time. Sigma Scan Pro software was employed in an attempt to calculate the percentage of pixels in each image that were in the range of green hues. Sections of approximately the same size were cropped from the middle of each of these images and analyzed using the software. The software was used to calculate the percentage of pixels in each image with a green hue. Although vegetative cover is often not green, it is the only color distinguishable from the range of yellows and browns that were present in the soil surface and the cover treatments in this experiment.

Statistical Analysis

Analysis of Variance (ANOVA) was performed on each round of samples collected and the experiment totals using SAS software. SAS software is available for use through license to the University of Tennessee. The results are discussed in the following chapter.

Chapter IV

Results & Discussion

Summary

The plots that received a cover treatment, predictably, exhibited greater resistance to erosive forces than the bare plots. The plots treated with the composted sewage sludge and the 50/50 mixture exhibited equivalent erosion resistance and greater vegetation establishment than those plots treated with straw. These results met expectations based upon review of published research using composted waste products as soil amendments and for erosion control. No significant differences in runoff or sediment were observed among the blocked slope percentages.

Timing

Logistics and the timing of precipitation twice prevented the collection of samples following a rain event. If more than 24 hours elapsed between the end of one rain event and the beginning of another, the erosivity index was calculated separately for each one. Some small rain events recorded by the data logger are not presented because they did not yield sediment and very little to no accumulation of moisture in the collection system. It is also suspected that the accumulation of dew on the impervious collection triangles may have contributed minute amounts of moisture to the collection systems. The 30 minute erosivity indices for the storm events are presented in Figure 5.

Experimental Compromises

At least one plot was visibly compromised by either the precipitation events, or possibly on occasion, burrowing animals, for each of the first seven rounds of samples collected. It was observed that at least 28 percent of the samples collected through the first five sampling events, and 31 percent through the first seven, exhibited discernable visual evidence to have been compromised due to pipe clogging and/or breaches of the diversion and collection triangles. It is suspected that more could have been compromised but lacked clear visible evidence following the precipitation events. Any visible breaches of the research plots were repaired during the sampling event in which they were discovered. Due to the amount breaches the research plots incurred during the course of this experiment they are described per sampling event, in Appendix II. These compromises contributed to the decision to split the presentation of results between the first seven and last four sampling events. The 19 days between sampling event seven and sampling event eight also provided a long drying period after vegetation was considered fully mature and the plots more stabilized which also contributed to the decision to split the presentation of results.

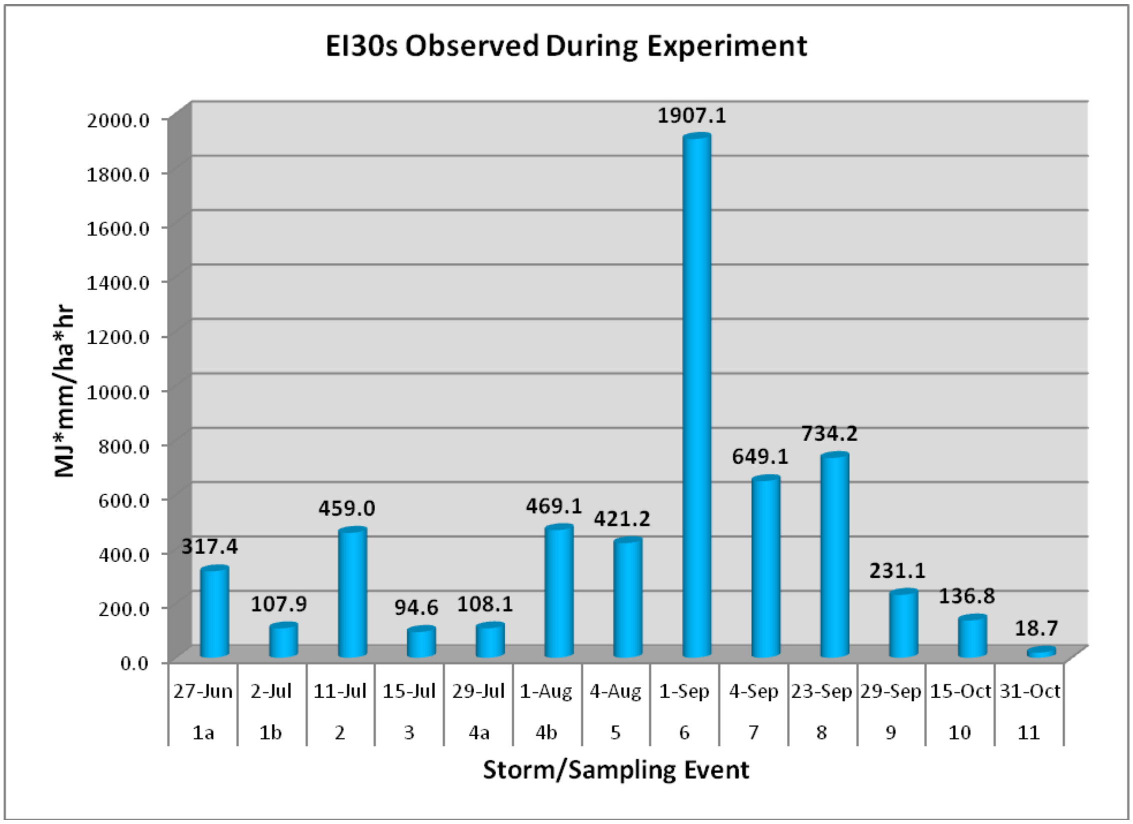

Figure 5 – Erosivity of 13 storms recorded over the 11 sampling events.

Sediment Yield

Because Plot 6 exhibited approximately four to six times greater sediment yield than the two other plots treated with the 50/50 mixture, it was decided to remove this plot from the calculations and presentation of results. Based on this observation, it is believed this plot was seriously compromised due to breaches of the collection and diversion triangles. Other breaches possibly occurred and are discussed in Appendix II. The results for the last four sampling events are also presented separately in a later section including data from all plots based on an observed increase in plot stability and vegetation maturity.

Generally, soil erosion among the cover treatments was not significantly different during this experiment. The bare control plots exhibited significantly greater soil erosion than the plots that received a cover treatment. During the first rain event the plots treated with the 50/50 mixture yielded the least amount of sediment followed by the CBS and straw treatments, although there were no significant differences. Through the rest of the early part of the experiment, as vegetation was getting established on plots that received cover treatments, the plots covered with straw produced slightly less soil loss (sampling events 2 through 5) but without significant difference. Starting with sampling event 6 the plots treated with CBS and the 50/50 mixture yielded less sediment than those treated with straw, as vegetation became established. This was the case for the remainder of the experiment although no significant differences were observed. Table 2 summarizes the average sediment yields for each treatment through the 11 sampling events and the experiment total average for each treatment excluding plot 6. Figure 6 summarizes the experiment total sediment yield for each plot. The much greater amount of sediment collected from plot 6 than the other two plots that received the same treatment is clearly illustrated. This degree of variation was not observed within the other treatments. Table 3 presents the measured sediment yields from each plot for each sampling event with the results for plot 6 (excluded from calculating treatment averages) highlighted in red.

Table 2. Summary of Average Soil Loss Among Treatments During 11 Storm Events

Event	Date	Erosivity*	Treatment Means^ (kg)							
		Index	Bare	sd	Straw	sd	CBS	sd	50/50	sd
1	07/02/03	317.4,107.9	11.17a	5.63	0.56b	0.30	0.42b	0.20	0.24b	0.07
2	07/11/03	459.0	28.78a	10.81	0.92b	0.55	1.64b	0.54	1.19b	0.34
3	07/15/03	94.6	16.33a	9.43	0.28b	0.05	0.72b	0.52	0.29b	0.25
4	08/01/03	108.1,469.1	37.61a	3.06	1.32b	0.77	1.44b	0.97	1.57b	0.22
5	08/04/03	421.2	45.00a	0.00	3.17b	3.54	3.65b	1.63	3.27b	2.15
6	09/01/03	1907.1	65.20a	38.76	1.02b	0.71	0.76b	0.67	0.62b	0.08
7	09/04/03	649.1	12.62a	6.97	0.40b	0.03	0.25b	0.18	0.24b	0.01
8	09/23/03	734.2	7.45a	3.33	0.19b	0.08	0.06b	0.07	0.06b	0.06
9	09/29/03	231.1	5.61a	2.75	0.16b	0.08	0.06b	0.06	0.06b	0.06
10	10/15/03	136.8	4.45a	2.53	0.38b	0.43	0.03b	0.03	0.07b	0.05
11	10/31/03	18.7	0.10a	0.11	0.00b	0.00	0.00b	0.00	0.00b	0.00
Total	For	Experiment	211.64a	59.83	8.42b	5.13	9.11b	3.87	7.60b	2.71

* Storm Erosivity (MJ*mm/ha*hr)

^ Treatment means with same letter in same event are not significantly different ($p < 0.05$)

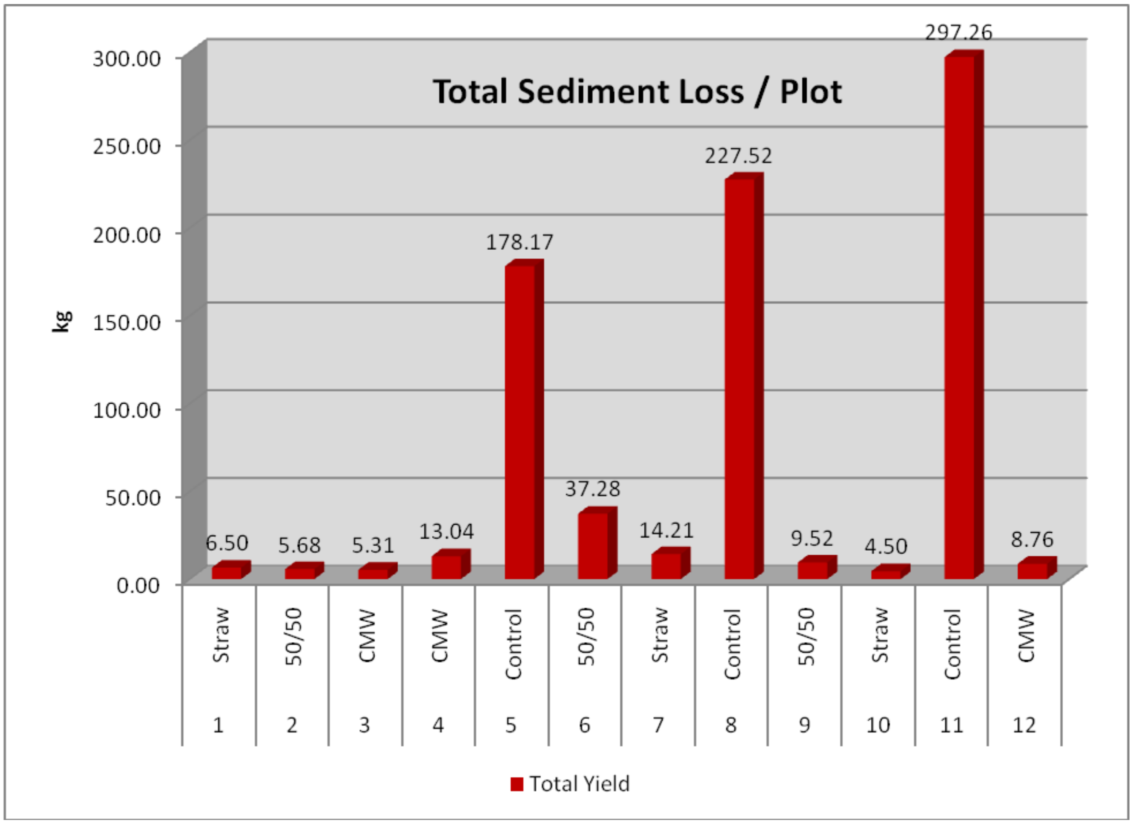

Figure 6 – Experiment total sediment collected from each plot

Table 3. Measured Sediment Yields (kg)

Event	Plot											
	1	2	3	4	5	6*	7	8	9	10	11	12
	Straw	50/50	CBS	CBS	Bare	50/50	Straw	Bare	50/50	Straw	Bare	CBS
1	0.80	0.28	0.40	0.63	12.23	0.24	0.66	5.09	0.19	0.23	16.19	0.24
2	0.96	0.95	1.38	2.26	33.23	1.64	1.45	16.45	1.43	0.35	36.66	1.28
3	0.30	0.12	0.32	1.31	11.04	1.07	0.32	27.22	0.47	0.23	10.73	0.53
4	1.28	1.73	0.83	2.56	36.20	6.77	2.11	35.51	1.42	0.57	41.13	0.94
5	1.50	1.75	2.08	5.34	45.00	5.26	7.24	45.00	4.78	0.77	45.00	3.52
6	0.60	0.56	0.18	0.61	25.42	17.05	1.84	67.32	0.67	0.61	102.85	1.49
7	0.42	0.23	0.08	0.24	6.77	4.17	0.37	10.77	0.25	0.40	20.32	0.43
8	0.22	0.02	0.01	0.04	4.08	0.49	0.10	7.53	0.10	0.25	10.74	0.14
9	0.20	0.02	0.01	0.03	2.45	0.38	0.06	6.90	0.11	0.21	7.49	0.12
10	0.21	0.03	0.02	0.02	1.54	0.21	0.06	5.72	0.11	0.87	6.09	0.06
11	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.02	0.00	0.00	0.05	0.00
Total	6.50	5.68	5.31	13.04	178.17	37.28	14.21	227.52	9.52	4.50	297.26	8.76

*Dropped from analysis

Runoff Volume

Because plot 6 was dropped from the sediment calculations (discussed earlier), it was dropped from the runoff calculations as well. The runoff results for the last four sampling events are also presented separately in a later section including data from all plots based on an observed increase in plot stability and vegetation maturity.

In general all cover treatments were significantly different than the bare treatment throughout the experiment. In sampling events 3, 7, 8 , 9, 10, and the experiment total the 50/50 treatment was significantly better at reducing runoff than straw and in sampling events 5 and 9 it was significantly better at reducing runoff than the CBS treatment. In sampling events 7 and 10 the CBS treatment was significantly better than straw but was never significantly better than the 50/50 treatment. Table 4 summarizes the average runoff results for each treatment through 11 sampling events and the experiment total average for each treatment excluding plot 6. Table 5 presents runoff as a percentage of precipitation. Figure 7 summarizes the experiment wide runoff totals for each plot. It is interesting to note that plot 1, a straw plot, produced more runoff than plot 8, a bare plot. Plot 6 is shown to have produced approximately twice the amount of runoff that the other two plots with the same treatment did. This degree of variation was not observed within the other treatments.

Table 4. Summary of Average Runoff Among Treatments During 11 Storm Events

Event	Date	Erosivity*	Treatment Means^ (l)							
			Bare	sd	Straw	sd	CBS	sd	50/50	sd
1	07/02/03	317.4,107.9	149.2a	169.0	67.8b	130.0	15.8b	40.1	48.7b	61.6
2	07/11/03	459.0	517.4a	225.4	212.8b	132.4	184.3b	91.5	129.9b	52.1
3	07/15/03	94.6	165.8a	108.4	76.4b	33.4	47.3bc	6.0	32.2c	1.3
4	08/01/03	108.1,469.1	392.7a	107.7	365.1a	141.7	328.6ab	88.7	263.7b	14.1
5	08/04/03	421.2	372.1ab	158.3	445.6a	123.6	374.7a	135.5	338.3b	121.7
6	09/01/03	1907.1	722.0a	354.9	122.7b	176.9	194.7b	161.6	82.5b	39.9
7	09/04/03	649.1	446.9a	201.3	242.2b	78.3	124.9c	58.0	147.8c	55.6
8	09/23/03	734.2	792.7a	597.3	243.1b	159.2	142.5bc	16.8	36.9c	18.7
9	09/29/03	231.1	176.2a	78.1	64.1b	37.1	57.9b	44.8	20.7c	7.9
10	10/15/03	136.8	203.9a	15.8	87.3b	9.9	47.0c	33.1	47.9c	7.0
11	10/31/03	18.7	13.9a	1.8	11.4b	5.1	10.6b	4.6	10.7b	3.9
Total	For	Experiment	3813.6a	1567.2	2023.1b	606.0	1582.5bc	402.4	1159.1c	197.1

* Storm Erosivity (MJ*mm/ha*hr)

^ Treatment means with same letter in same event are not significantly different ($p < 0.05$)

Table 5. Summary of Average Runoff as a Percentage of Precipitation

Event	Date	Erosivity	Runoff as Percentage of Precipitation			
			Bare	Straw	CBS	50/50
1	07/02/03	317.4, 107.9	10.65%	5.36%	1.65%	3.47%
2	07/11/03	459.0	49.46%	27.23%	23.53%	16.59%
3	07/15/03	94.6	70.41%	34.52%	21.26%	14.47%
4	08/01/03	108.1, 469.1	41.97%	39.07%	35.13%	28.18%
5	08/04/03	421.2	50.71%	60.80%	58.44%	46.11%
6	09/01/03	1907.1	94.69%	28.79%	25.54%	10.81%
7	09/04/03	649.1	58.61%	30.19%	16.38%	19.38%
8	09/23/03	734.2	73.97%	22.68%	13.30%	3.44%
9	09/29/03	231.1	47.49%	17.29%	15.62%	5.57%
10	10/15/03	8.04	61.84%	26.47%	14.26%	14.51%
11	10/31/03	1.10	5.11%	4.18%	3.88%	3.94%
Total	For	Experiment	49.88%	26.58%	20.79%	15.16%

* Storm Erosivity (MJ*mm/ha*hr)

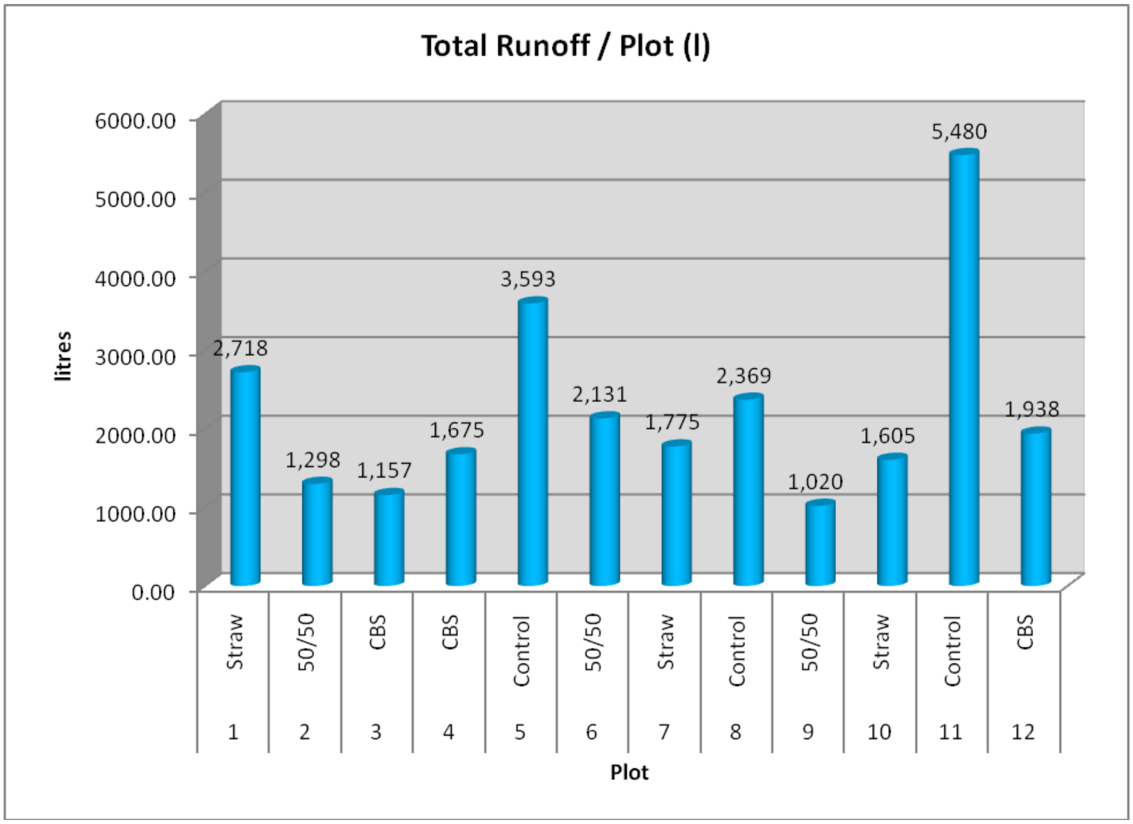

Figure 7 – Experiment total runoff collected from each plot

Table 6 presents the measured runoff from each plot for each sampling event with the results for plot 6 (excluded from calculating treatment averages) highlighted in red. Figure 8 illustrates the difference in runoff among treatments for each sampling event. For the entire experiment the CBS mixed with shredded wood (50/50) reduced runoff by 69.6 percent (excluding plot 6). The CBS treatment reduced runoff by 58.5 percent. Straw plots reduced runoff by 47.0 percent. Figure 9 illustrates the difference in sediment yield among treatments for each sampling event. For the entire experiment the sediment losses were essentially equal among cover treatments with the 50/50 mix (excluding plot 6) producing a 96.8 percent reduction. Straw and CBS achieved 96.4 percent and 96.1 percent respectively. The amount of runoff and sediment collected form the bare plots greatly diminishes the amounts collected from the plots that received a cover treatment. For that reason the bare plots were excluded from Figure 10 to better visualize the difference among treatments.

Table 6. Measured Runoff Volumes (l)

Event	Plot											
	1 Straw	2 50/50	3 CBS	4 CBS	5 Bare	6* 50/50	7 Straw	8 Bare	9 50/50	10 Straw	11 Bare	12 CBS
1	226	5	0	69	338	8	0	13	92	0	96	0
2	366	167	204	264	517	273	127	127	93	147	518	85
3	115	31	40	51	59	106	58	139	33	58	273	50
4	529	274	236	413	516	302	290	348	254	278	314	336
5	539	424	277	473	393	237	493	204	252	306	519	537
6	179	111	74	132	520	515	413	514	54	66	1132	378
7	167	187	128	65	424	409	206	258	108	318	659	181
8	390	24	134	132	510	72	74	390	50	266	1479	162
9	96	15	29	35	116	110	23	148	26	73	264	110
10	97	53	23	33	186	90	77	215	43	87	210	85
11	15	8	11	6	15	8	14	12	14	6	15	15
Total	2718	1298	1157	1675	3593	2131	1775	2369	1020	1605	5480	1938

* Dropped from analysis

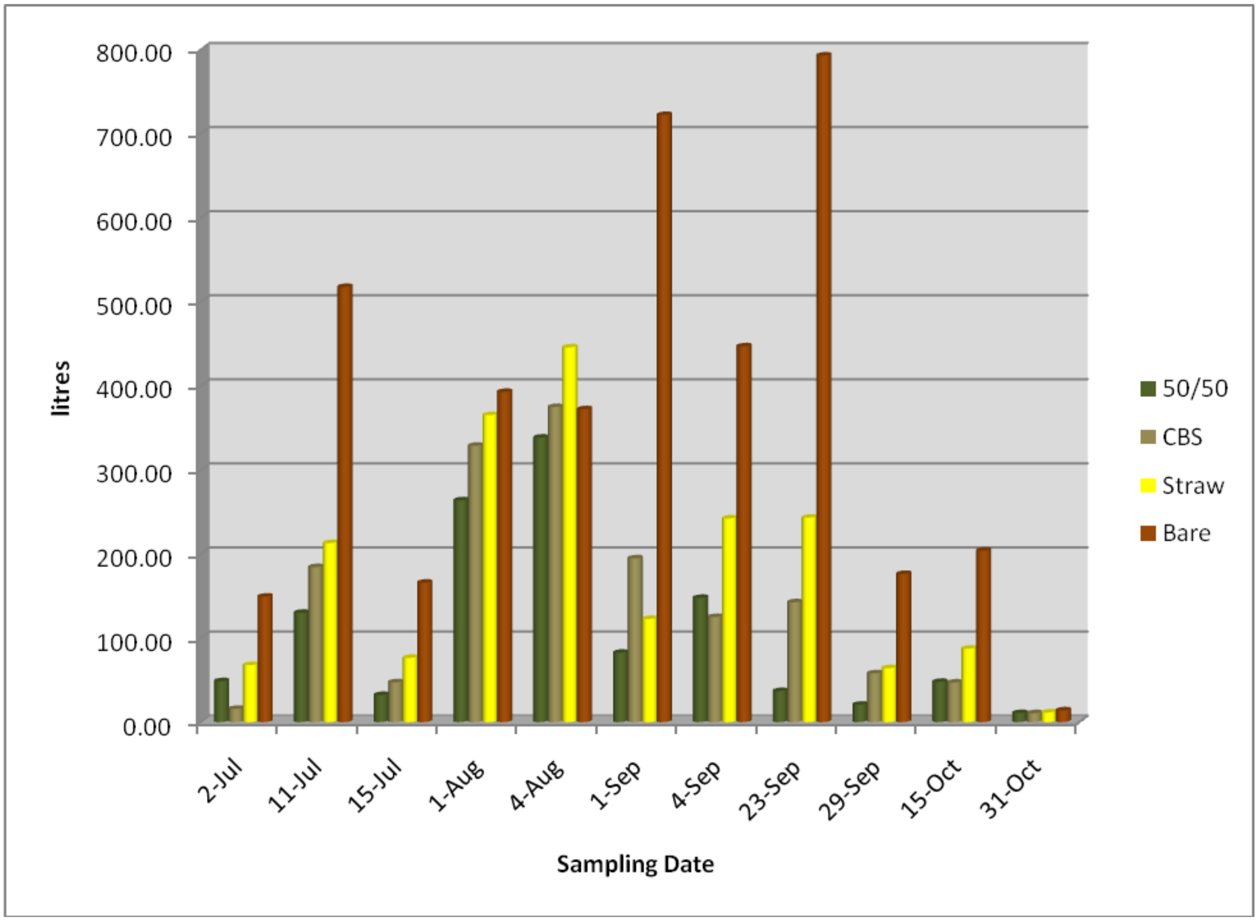

Figure 8 – Average runoff from all treatments for each sampling event.

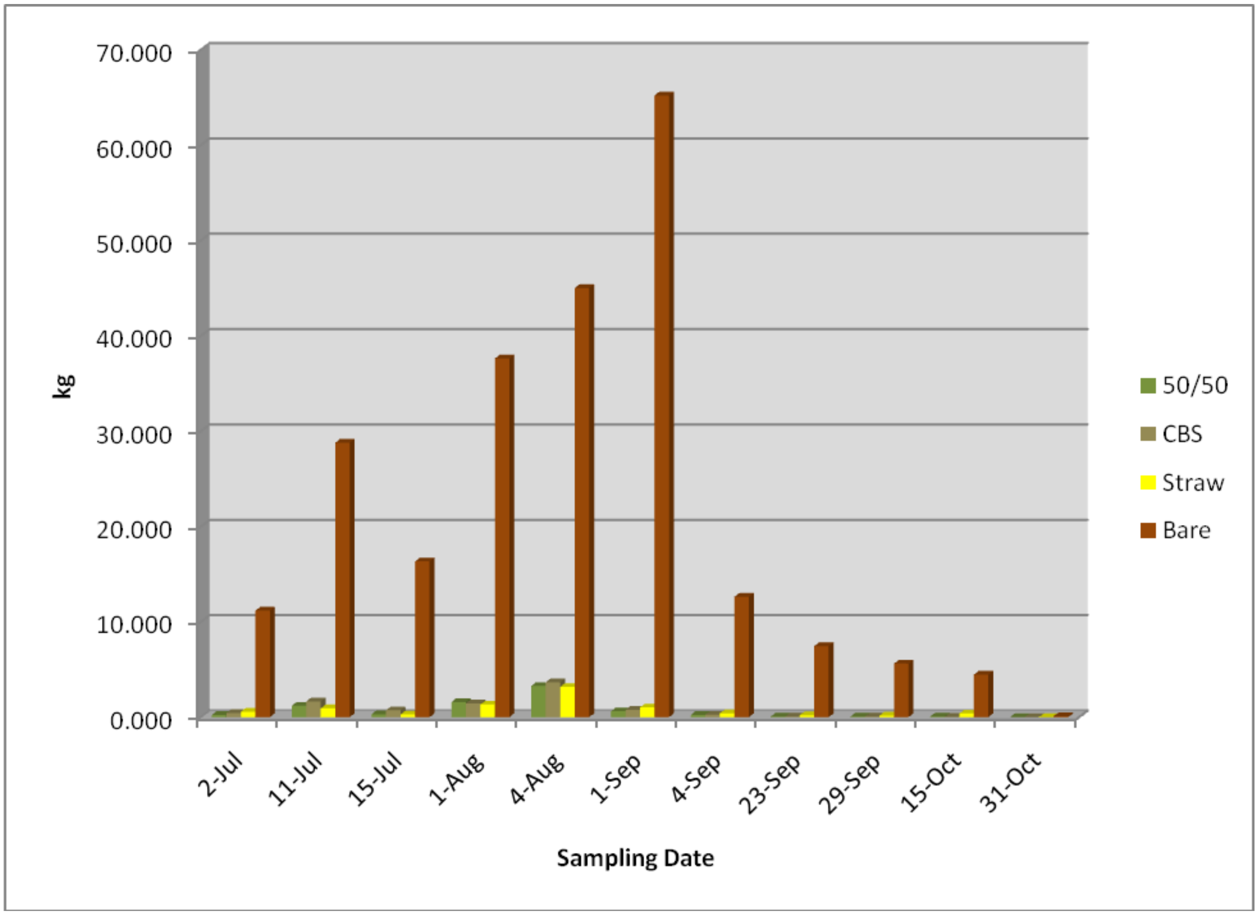

Figure 9 – Average sediment Yield from all treatments for each sampling event.

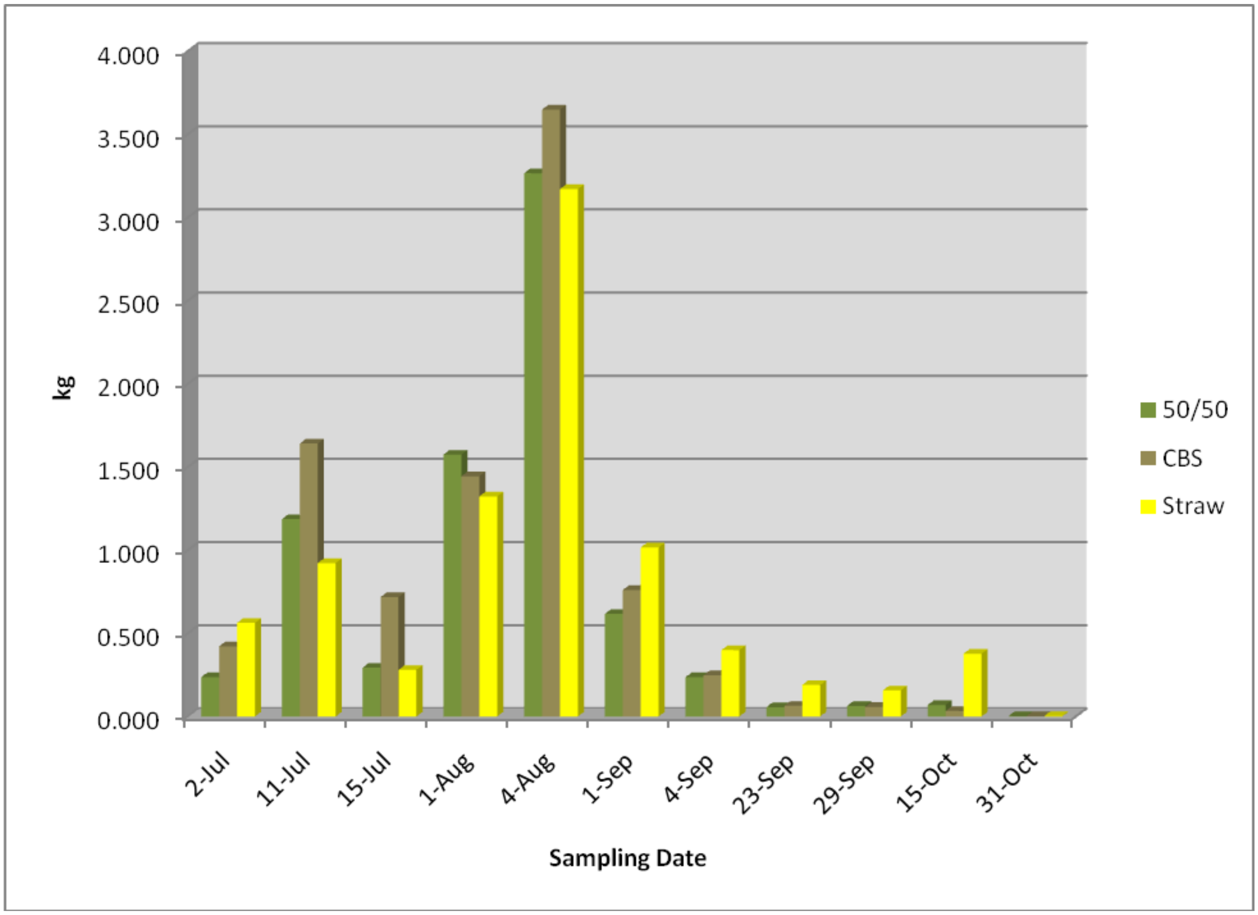

Figure 10 – Average sediment yield from cover treatments for each sampling event.

Sediment Yield Last Four Sampling Events

Beginning with sampling event number eight, no more discernable breaches of the research plots were found and the sediment yields from plot 6 became more similar to the other two plots that received the same treatment so here it is included in the treatment means and ANOVA was used. It is reasoned that by this point in the experiment the research plots and the area around them had become more stable through both settling and removal of most of the looser soil materials during the first seven precipitation events. This is a reasonable assumption because the EI30 for the single precipitation event that preceded the eighth round of sample collection was the second greatest measured during the experiment, but did not result in the magnitude of plot disturbance observed in the preceding events. At this point the vegetation was considered fully mature and there had been a 19 day dry period since sampling event seven.

Once the plots became more stabilized and vegetation had been well established (Sampling Events 8 - 11), all cover treatments were significantly different than the bare treatment, except for sampling event 11, but there were no significant differences observed among the cover treatments. There were no significant differences for the total of the last four events among the cover treatments either, but all were significantly different than the bare treatment. These results are presented in Table 7 and Figure 11.

Table 7. Summary of Average Soil Loss Among Treatments During Last 4 Storm Events

Event	Date	Erosivity*	Treatment Means^ (kg)			
			Control	Straw	CBS	50/50
8	09/23/2003	734.2	7.450a	0.189b	0.064b	0.200b
9	09/29/2003	231.1	5.614a	0.157b	0.057b	0.168b
10	10/15/2003	136.8	4.452a	0.377b	0.033b	0.116b
11	10/31/2003	18.7	0.097a	0.003a	0.001a	0.002a
Totals			17.613a	0.726b	0.255b	0.486b

* Storm Erosivity (MJ*mm/ha*hr)
^ Treatment means with same letter in same event are not significantly different ($p < 0.05$)

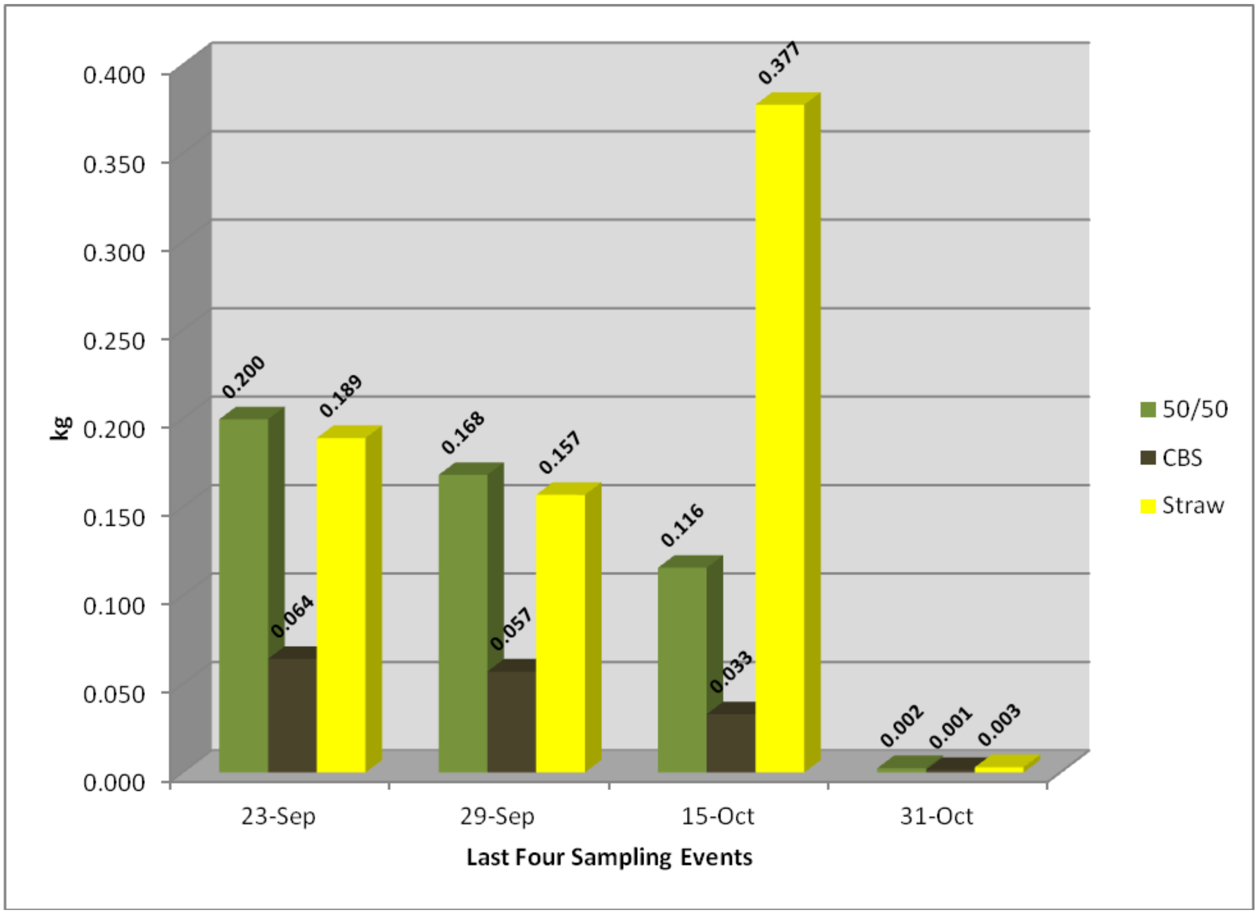

Figure 11 – The performance of the cover treatments for the last four sampling events is presented separately because by this point the plots had become more stable and no breaches were found during these sampling events.

Runoff Volume Last Four Sampling Events

Runoff volume for The CBS and 50/50 treatments were significantly less than the bare plots in sampling events 8 and 9, but the straw treatment was not. In sampling event 10 all cover treatments were observed to be significantly less than the bare treatment with no significant differences among covers. There was no significant difference among all treatment for sampling event 11, the lowest energy storm event of the experiment. For the totals of the last four sampling events all cover treatments were significantly different than the bare treatment, but there was no significant difference between the cover treatments. These results are presented in Table 8 and Figure 12.

Table 8. Summary of Average Runoff Among Treatments During Last 4 Storm Events

Event	Date	Erosivity*	Treatment Means^ (l)			
			Control	Straw	CBS	50/50
8	09/23/2003	734.2	792.71a	243.06ab	142.49b	48.67b
9	09/29/2003	231.1	176.17a	64.12ab	57.92b	50.50b
10	10/15/2003	136.8	203.89a	87.28b	47.03b	61.82b
11	10/31/2003	18.7	13.91a	11.38a	10.57a	9.74a
Totals			1186.68a	405.84b	258.01b	170.73b

* Storm Erosivity (MJ*mm/ha*hr)

^ Treatment means with same letter in same event are not significantly different ($p < 0.05$)

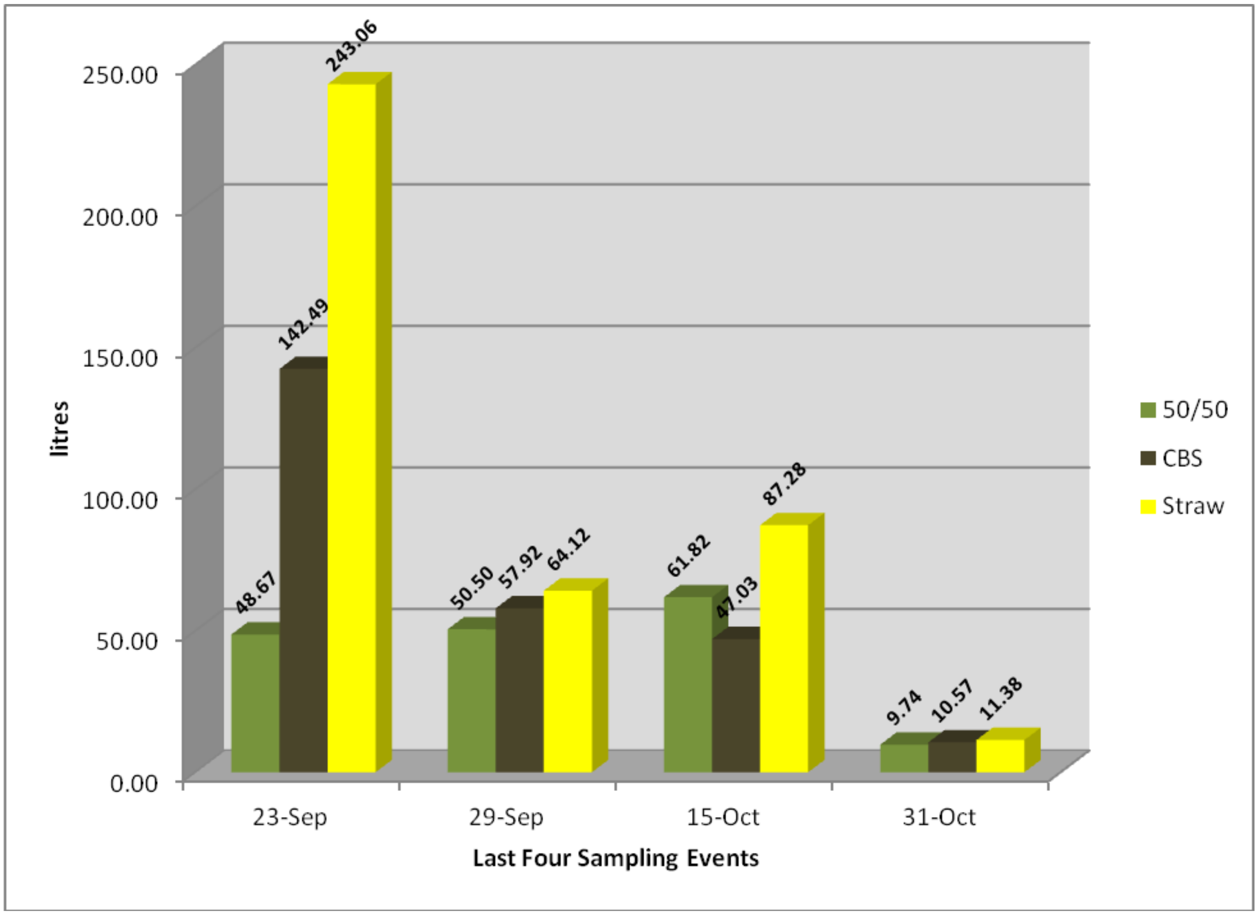

Figure 12 - The performance of the cover treatments for the last four sampling events is presented separately because by this point the plots had become more stable and no breaches were evident during these sampling events.

Digital Image Evaluation

The digital images captured clearly show a stark difference in the vegetation grown under the three cover treatments. However, the average percent of surface covered by vegetation could not be determined by analyzing for green hues. As the vegetation, cover materials, and soil surface dried out their hues became more similar, especially on the straw plots. Beginning with the fourth sampling event the results of the software did not agree with visual observation and were sporadic from there forward. Therefore, digital cover analysis using Sigma Scan Pro was abandoned following the August 22 sampling event. Attempts were made to manipulate the software in such a way as to differentiate between the vegetation and the underlying ground following drying, and the accompanying color changes, in both the vegetation ground surface, but they were unsuccessful. It can be seen in the figures provided that the amount of green vegetation is dramatically greater on the plots treated with biosolids. It is noticeable that there are consistently greater amounts of green colors for the CBS treatment, followed by 50/50, and straw, demonstrating greater amounts of CBS keeps plants greener and healthier as would be expected.

Practicality

Digital color analysis, at the time, did not seem to be a practical method of estimating vegetative cover if the color wavelengths of the vegetation have significant overlap with the color wavelengths of the underlying ground. Software of this type has been successfully used to determine coverage in other experiments in subsequent years. These methods would seem to be better employed on a wider range of soils and vegetation if moisture is regulated, keeping the vegetation lush and the soil color bold. As this was primarily an erosion control experiment additional moisture application was not desirable and hence not part of the experimental design. The location and ruggedness of this experiment's location would have also presented considerable difficulty in getting irrigation to the plots on a regular basis.

Selected digital images of the plots captured during this experiment are presented in chronological progression for visual comparison on the following page. A chronological progression of the images captured for each plot that was seeded and treated is presented as Appendix 1. It is quite obvious, by the concentration of vegetation at the lower ends of the plots treated with straw, that the seed mixture applied to these plots was possibly transported to the lower ends of the plots through erosion processes prior to seed germination and plant establishment, or did not germinate or survive the drier conditions on the upper portion. It is impossible to speculate how much, if any, of the seed moved completely off of these plots. This also appears to have occurred to a much lesser extent on the plots treated with the 50/50 mixture. The plots treated with CBS, and the 50/50 mixture, clearly demonstrated their superior ability to not only establish vegetation, but to also keep seed where it is applied. These images provide a compelling visual argument for using CBS, and mixtures of CBS, rather than straw for erosion control and vegetation establishment. Coverage may have been quantified with the same device used to measure the percent coverage of the cover materials, but it was feared this would disturb the plots too much and interfere with the erosion study.

In Figure 13, three plots are shown in chronological progression from top to bottom and in decreasing plant coverage from left to right. The lack of plant material is clearly evident on the upper portion of the straw plot. Vegetation is also clearly less dense on the upper portion of the 50/50 plot. It is clearly visible here that the CBS plot produced the densest and most evenly distributed plant stand.

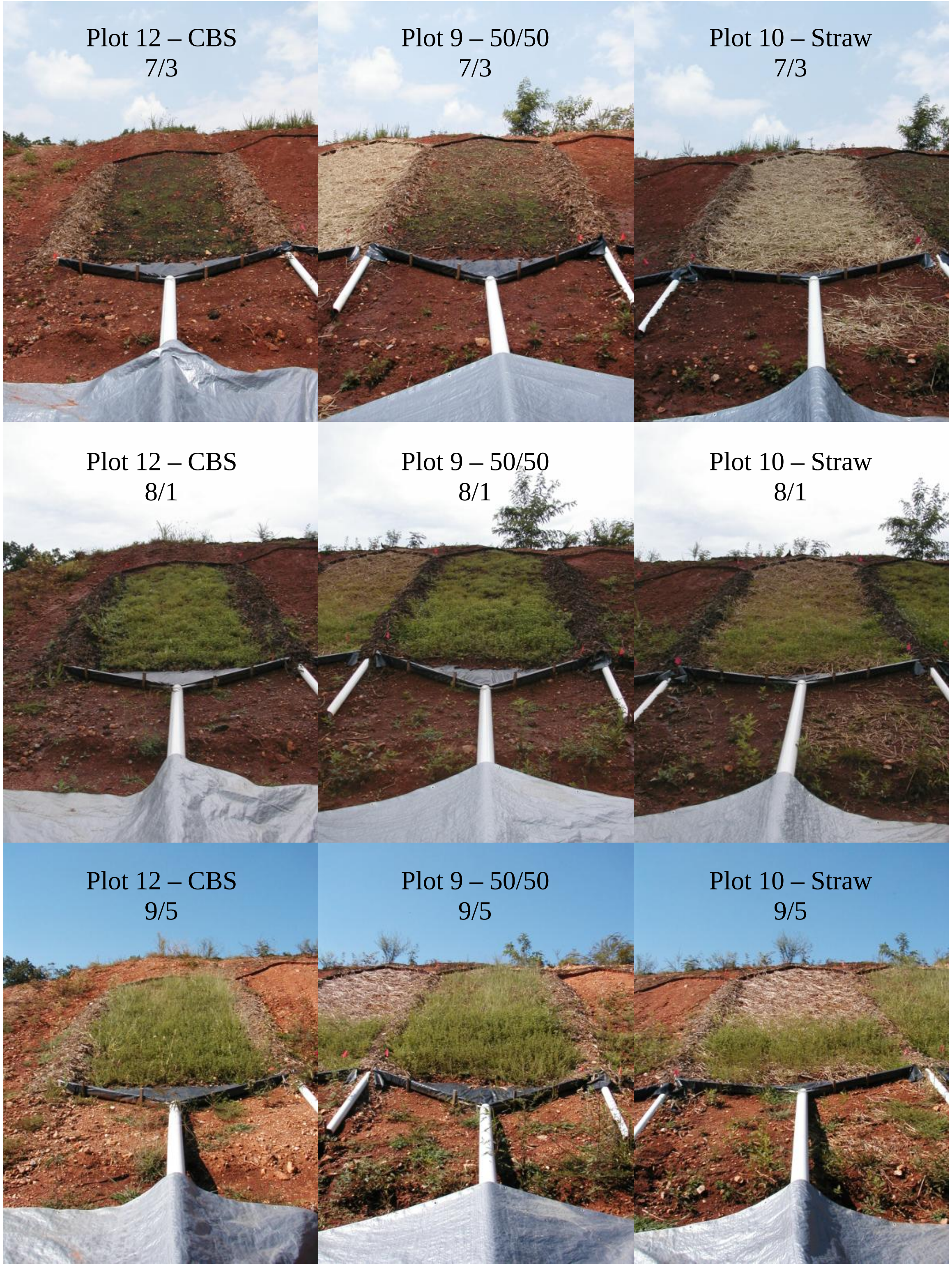

Figure 13. – Visual comparison of vegetation establishment between adjacent plots.

Chapter V

Conclusions

Composted biosolids were demonstrated in this experiment to be just as effective for reducing runoff volume and soil loss on steep slopes as straw, the most commonly used treatment. The lack of any significant difference in sediment yield between plots with the straw treatment, and plots treated with biosolids, may have been in part the result of the seed applied to the straw plots washing down and concentrating on their lower ends early in the experiment, forming a denser stand of vegetation that effectively acted as a sort of dike or filter strip against the runoff flow down the plot. The images captured of the vegetative growth progression on the plots also illustrate this observation. This phenomenon may have also been the result of decreased germination and/or survival rates of seed applied to the upper portion of the straw plots due to faster drying rates on the upper parts of slopes resulting in less water available for plant use. The plots treated with straw also likely had less water and nutrients available overall due to the greater capacity of the other two treatments to make these available for plant life. Improvements in soil quality imparted by the compost would have also allowed for better root penetration and stability which also improve plant health. The lack of a significant difference in sediment yield between plots that received a cover treatment throughout the study, and not just in the study totals, illustrates equal effectiveness over a range of storm energies. The performance of the straw treatment appeared to have diminished somewhat after the vegetation was well established, although there were still no significant differences observed in sediment yield. The long dry period between sampling events five and six and between sampling events seven and eight during the summer heat likely worked to diminish the effectiveness of the vegetation due to plant stress. These dry periods helped to more clearly show the superior ability of composted biosolids products for maintaining plant vigor on harsh landscapes such as the one used in this study. The significant difference in runoff volume between the 50/50 treatment and the straw treatment that was observed in some storm events and the experiment total is likely best explained by greater absorption by the shredded wood, hydrophobicity exhibited by the straw or some combination of both. This experiment well illustrated the superior ability of CBS at keeping plants greener longer due to the much greater nutrient and water holding capacities of compost and its greater effect on improving soil quality than lesser organic materials. Processing and using sewage sludge and woody wastes in the manner demonstrated in this project can redirect a significant portion of the sewage waste stream to beneficial reuse.

Insights & Recommendations

Several lessons were learned and some insight was gained through the course of this research project. This section is presented with the hopes of helping to streamline construction and data collection of other similar projects and encourage their implementation. These recommendations will help increase efficiency and mitigate the strain involved in future projects of this type.

It was of particular concern to conduct this research in the most economically conservative manner possible, in lieu of serious budget constraints at the time, using the most readily available materials and supplies on hand. In was fortunate in this experiment that the materials to be evaluated were available on site. Large piles of the CBS and the shredded wood waste used to make 50/50 treatment were located near the base of the slope where the experiment was conducted and were easily transported the short distance in a wheelbarrow. In hindsight more of this readily available material should have been spread over the bare soil above the experimental plots to curb erosion and runoff before it ever got to the diversion triangles. This could have prevented spill over and clogging of the drain pipes. The bare area above the plots did not appear to be that significant on the front end, but a high intensity storm event can quickly prove appearances can be deceiving. This material should have also been applied liberally in the area around the collection systems. The weight of the buckets made sample collection strenuous work. Carrying these loads through sticky mud made the work more hazardous than it had to be, by making it harder to maintain balance, increasing the incidence of muscle strains and sprains. If an abundance of material is not available, it is highly recommended to procure some prior to sample collection, or put down gravel or walk boards.

Tip over was a constant concern during transport. A simple organizer built from two by four timbers would have been beneficial would be beneficial to transporting buckets full of sediment laden runoff in the back of a truck, the practicality of such increasing with transportation distance. This would greatly reduce the risk of tip over due to sudden stops or turns, which could occur no matter how well the buckets are wedged against each other.

One problem was prevalent with the use of tarps to cover the collection systems, rather than more expensive construction. The sharp corners on the V-channels that transported runoff from one collection bucket to the next had a tendency to cut through the tarps covering them. This required the constant use of duct tape to keep the collection systems sheltered from precipitation. These corners need to be rounded off or covered with a dull material durable enough to hold up to high winds causing the tarps to rub over them.

The use of telemetry should definitely be incorporated into research dependent upon natural precipitation. The nature of pop-up thunderstorms makes rainfall coverage highly variable. It was noticed on more than one occasion during this experiment, by monitoring the weather station at the Bull Run Steam Plant that it can rain on one side of the river and not the other. This adds to the cost but is definitely worth it, as it would take the guess work out of determining when to inspect plots that are at a considerable distance from the base of operations.

The steepness and nature of the material that comprised the slope in this experiment often proved to be overwhelming to the collection system used until the slope became more stable. Future users of this collection system on slopes comprised of material similar to the one used here should definitely consider evaluating greater coverage percentages or reduced plot sizes. This experiment certainly tested the upper limits of the collection systems capabilities.

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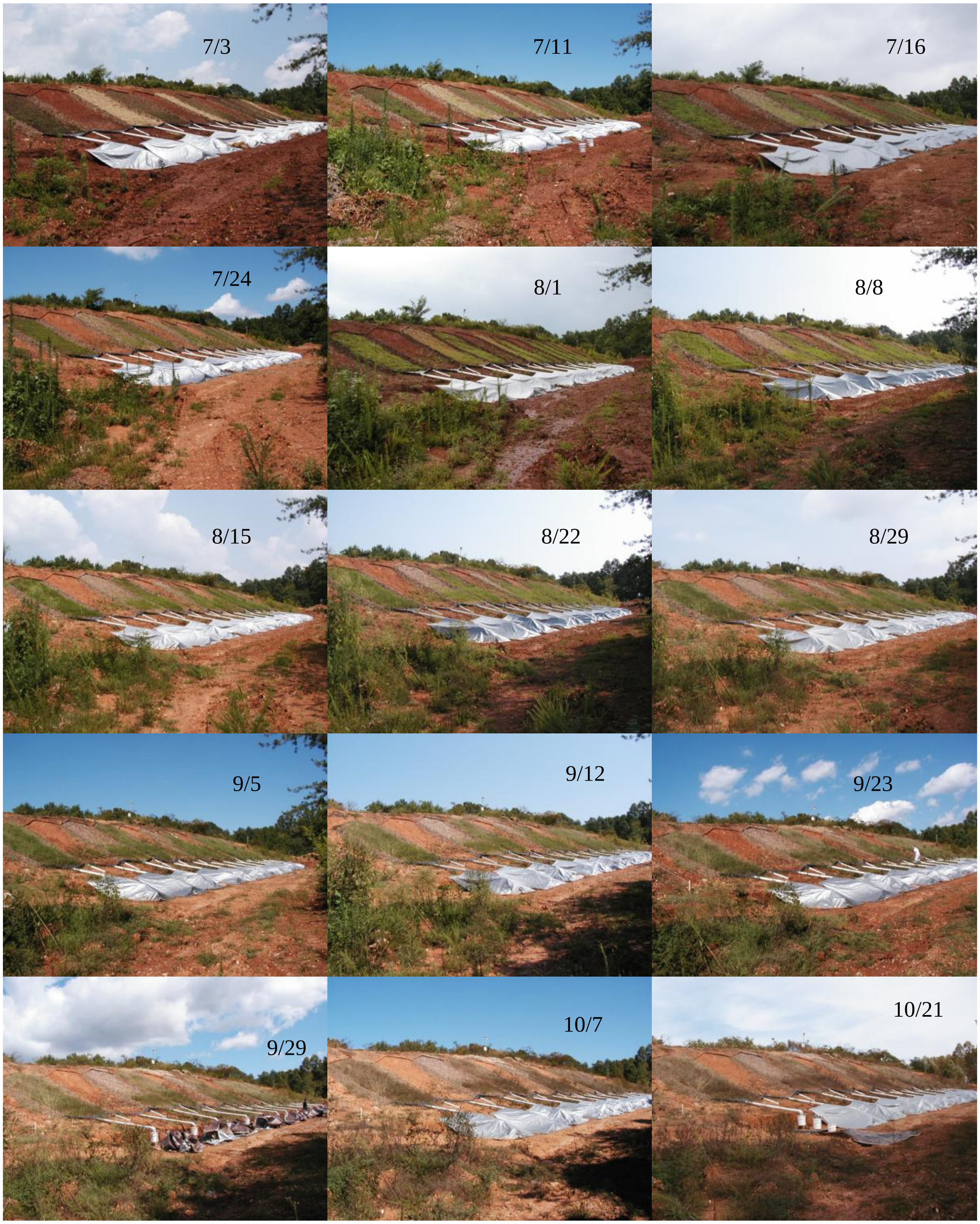
Appendices

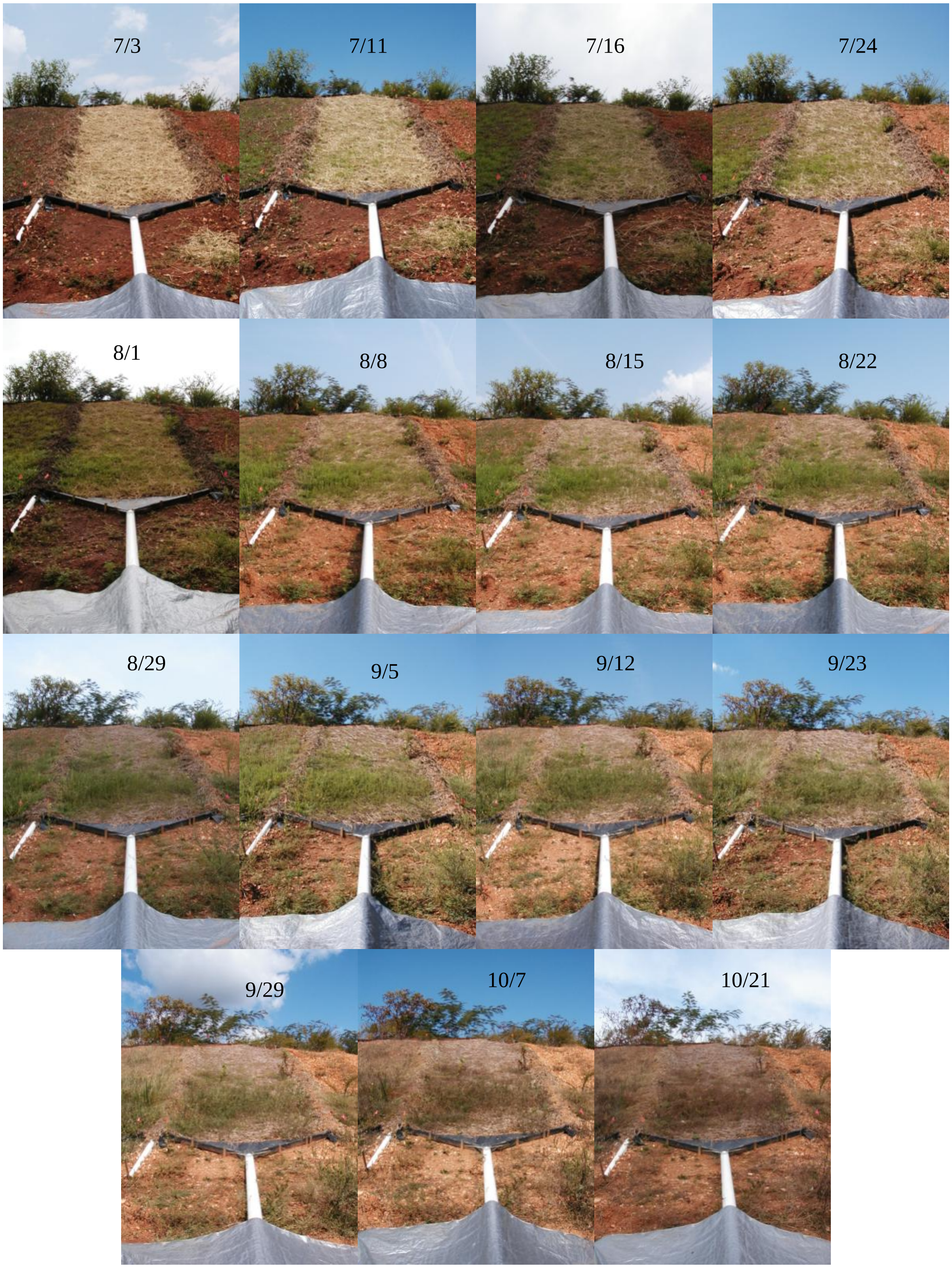
Appendix I

Plot Images

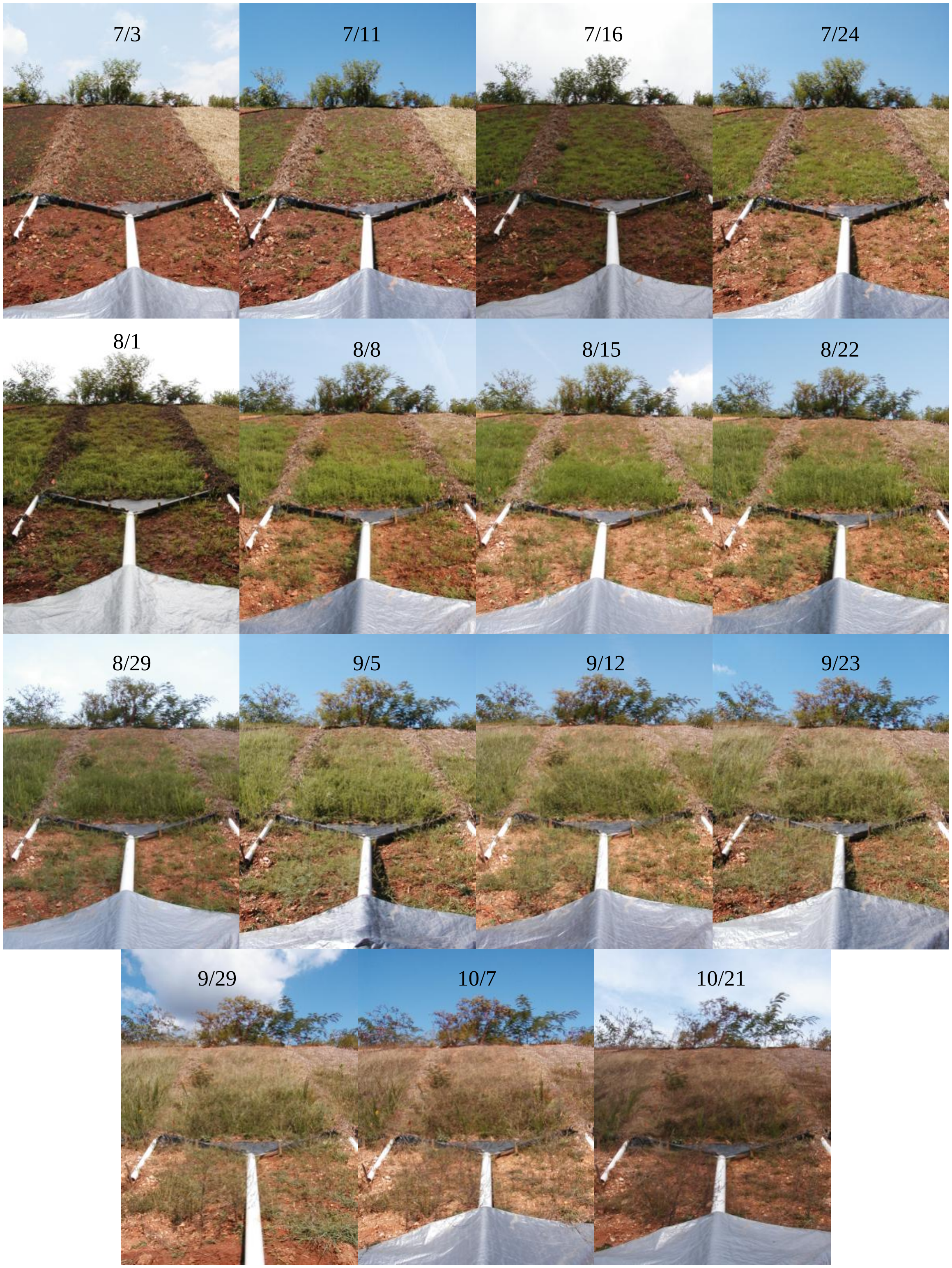
Chronological Progression of Images Captured Showing the Research Site



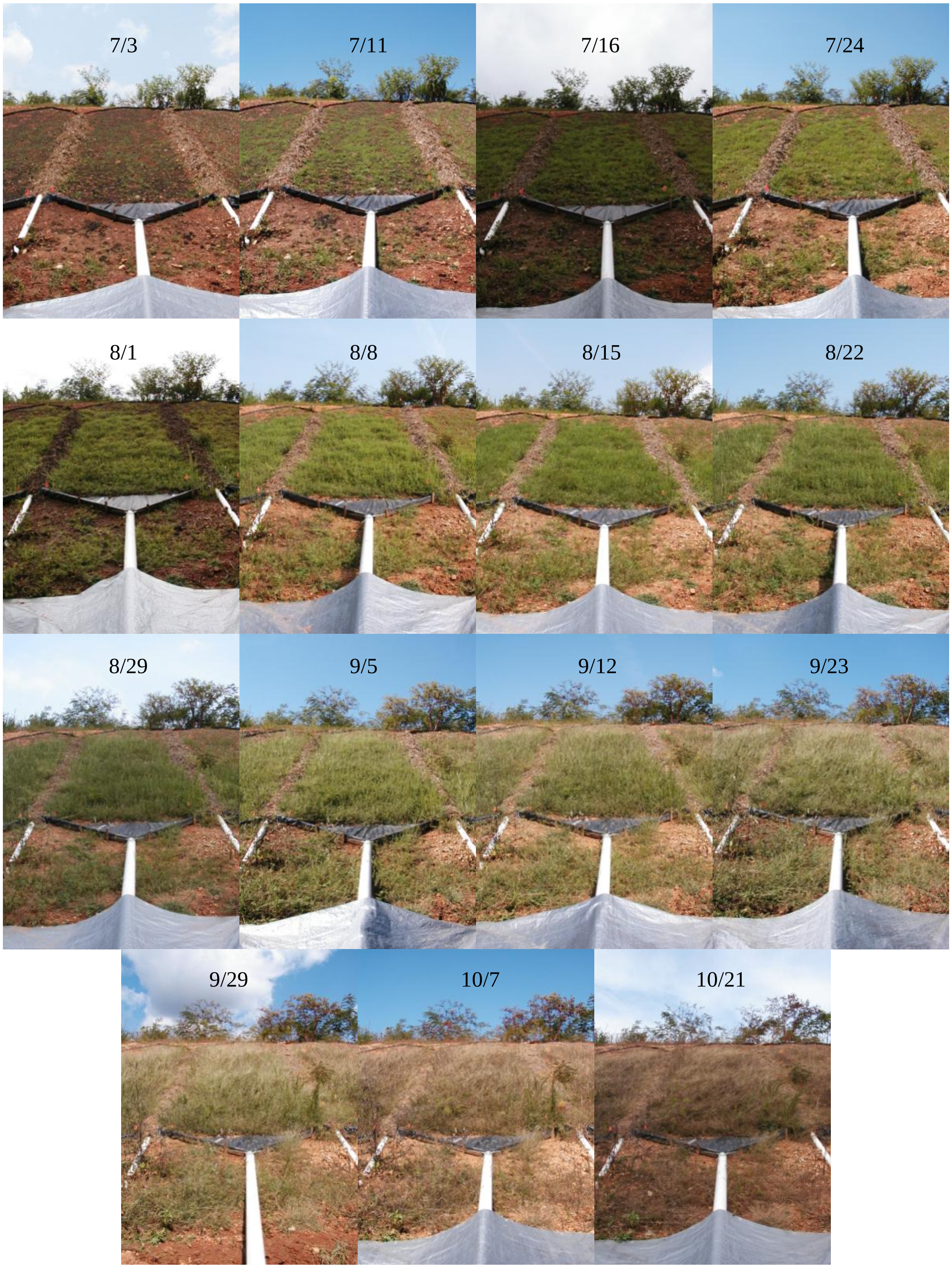
Chronological Progression of Images Captured Showing Plot 1 Treated with Straw



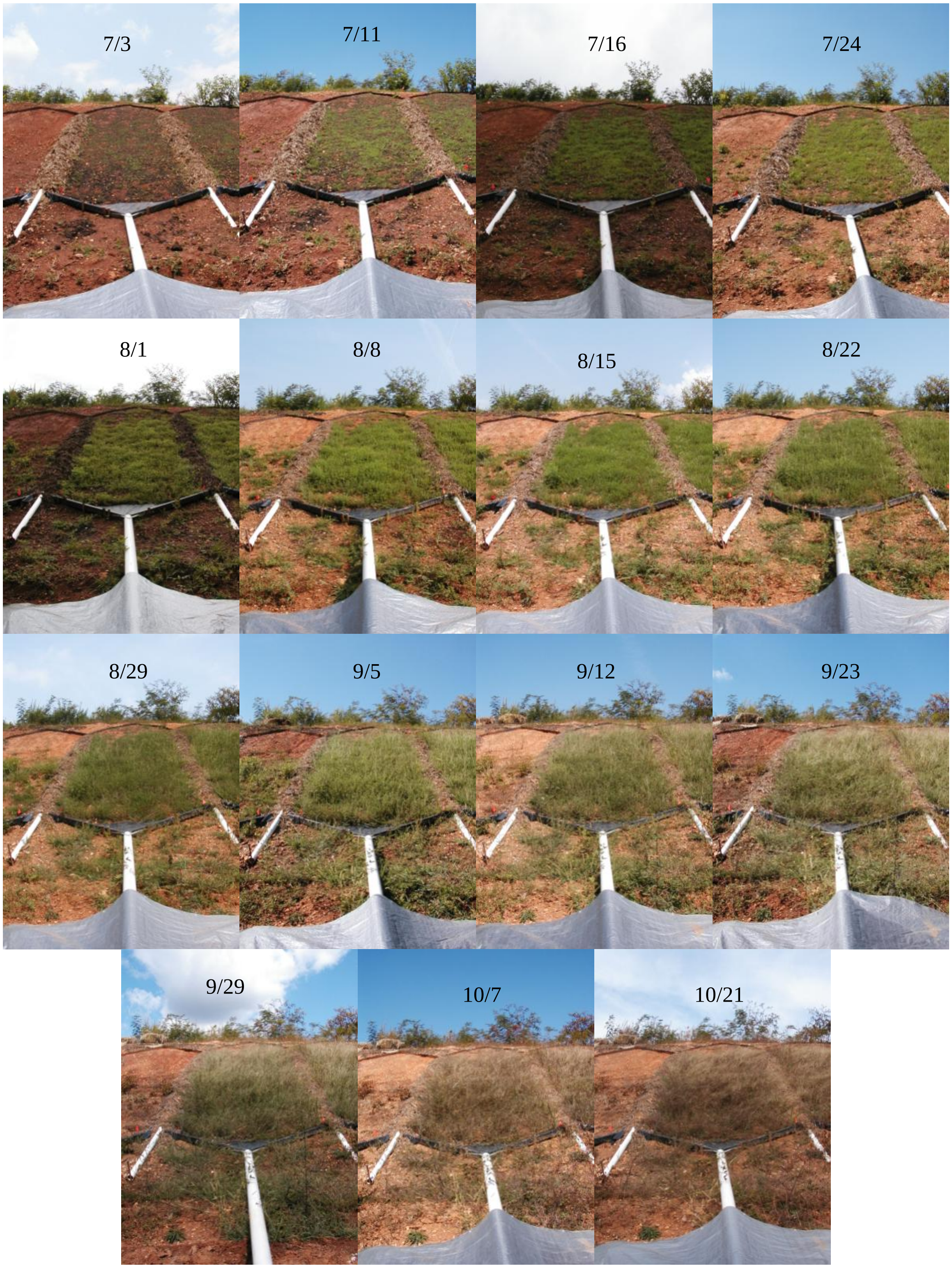
Chronological Progression of Images Captured Showing Plot 2 Treated with 50/50



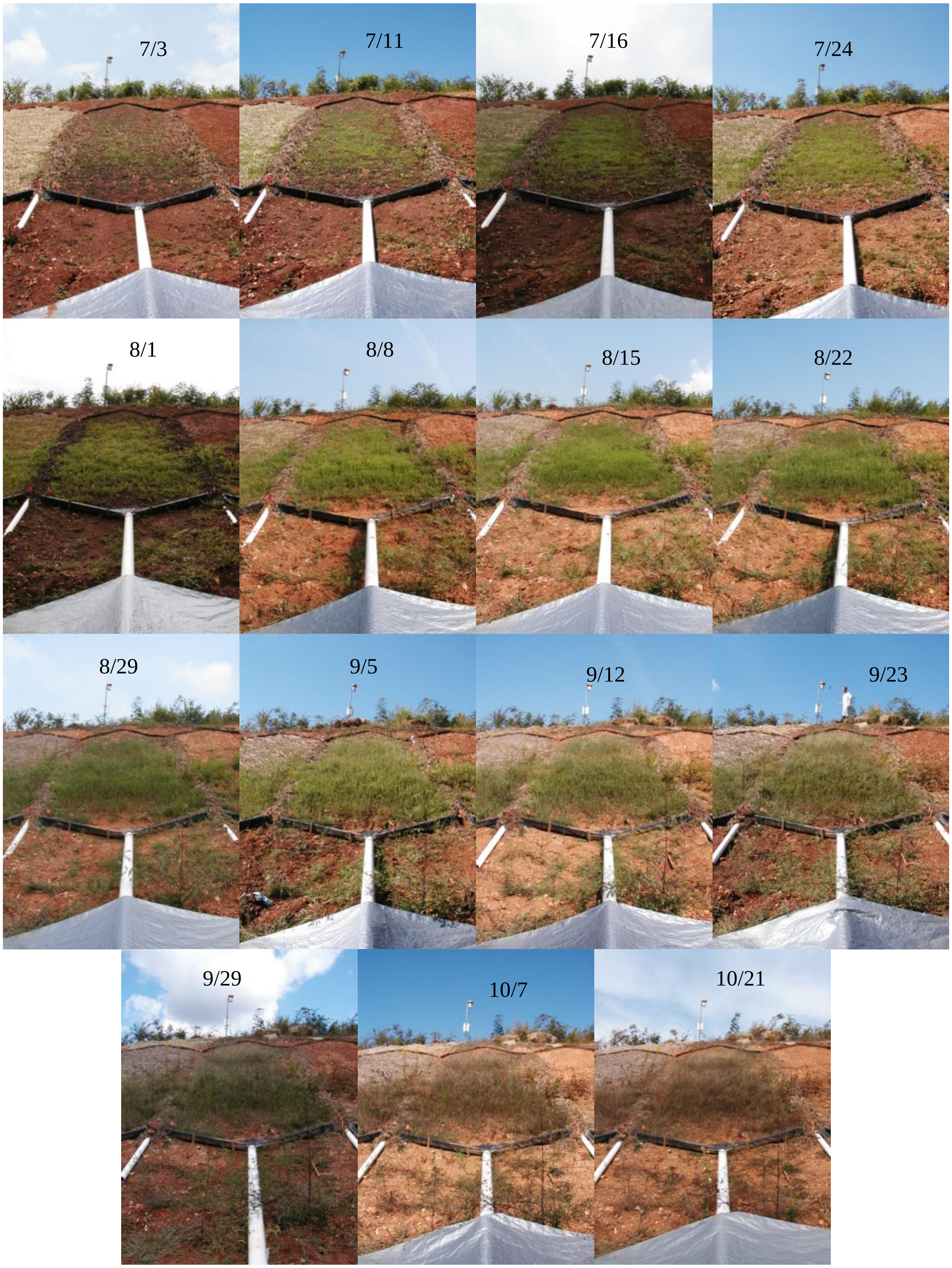
Chronological Progression of Images Captured Showing Plot 3 Treated with CBS



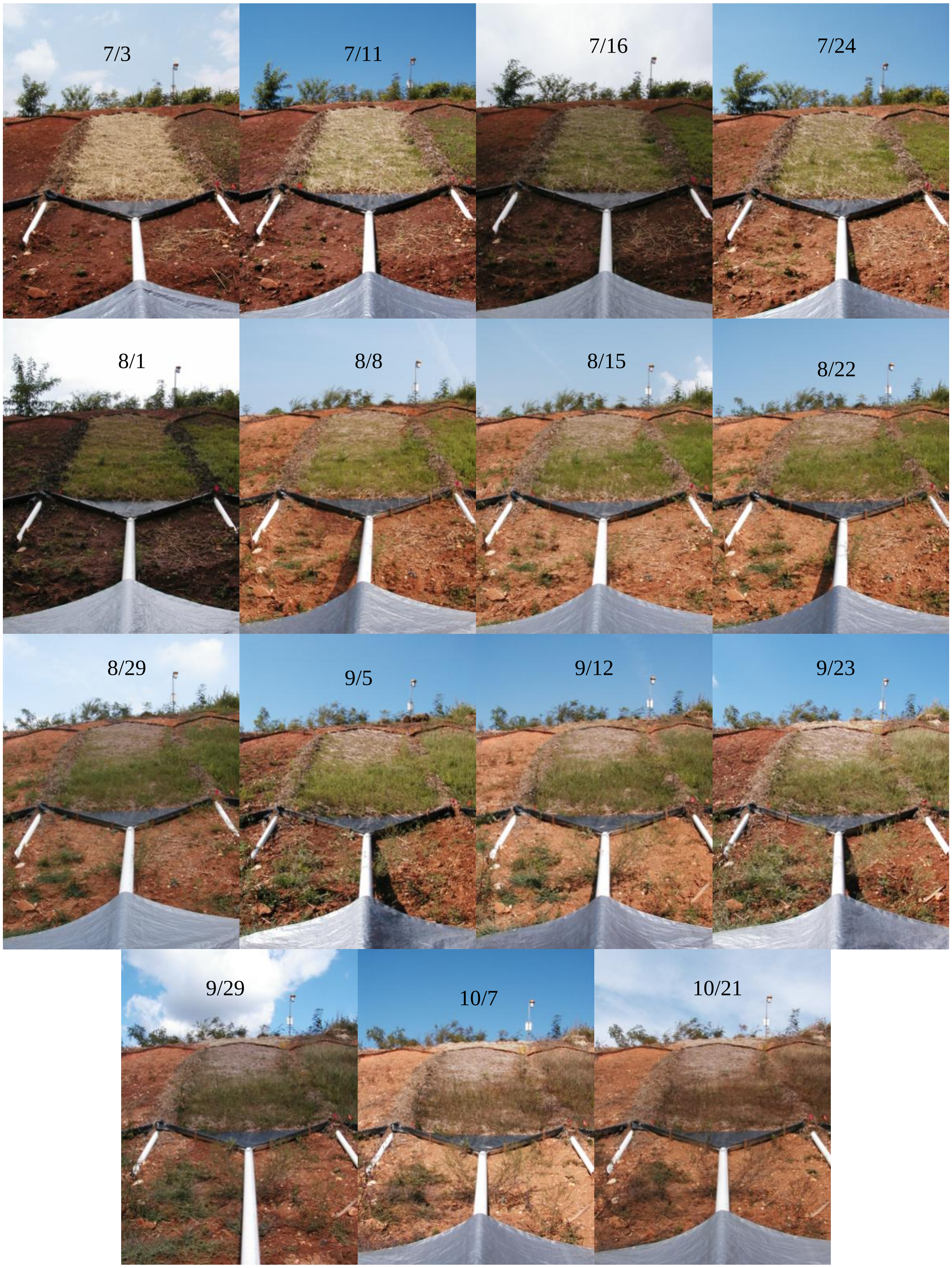
Chronological Progression of Images Captured Showing Plot 4 Treated with CBS



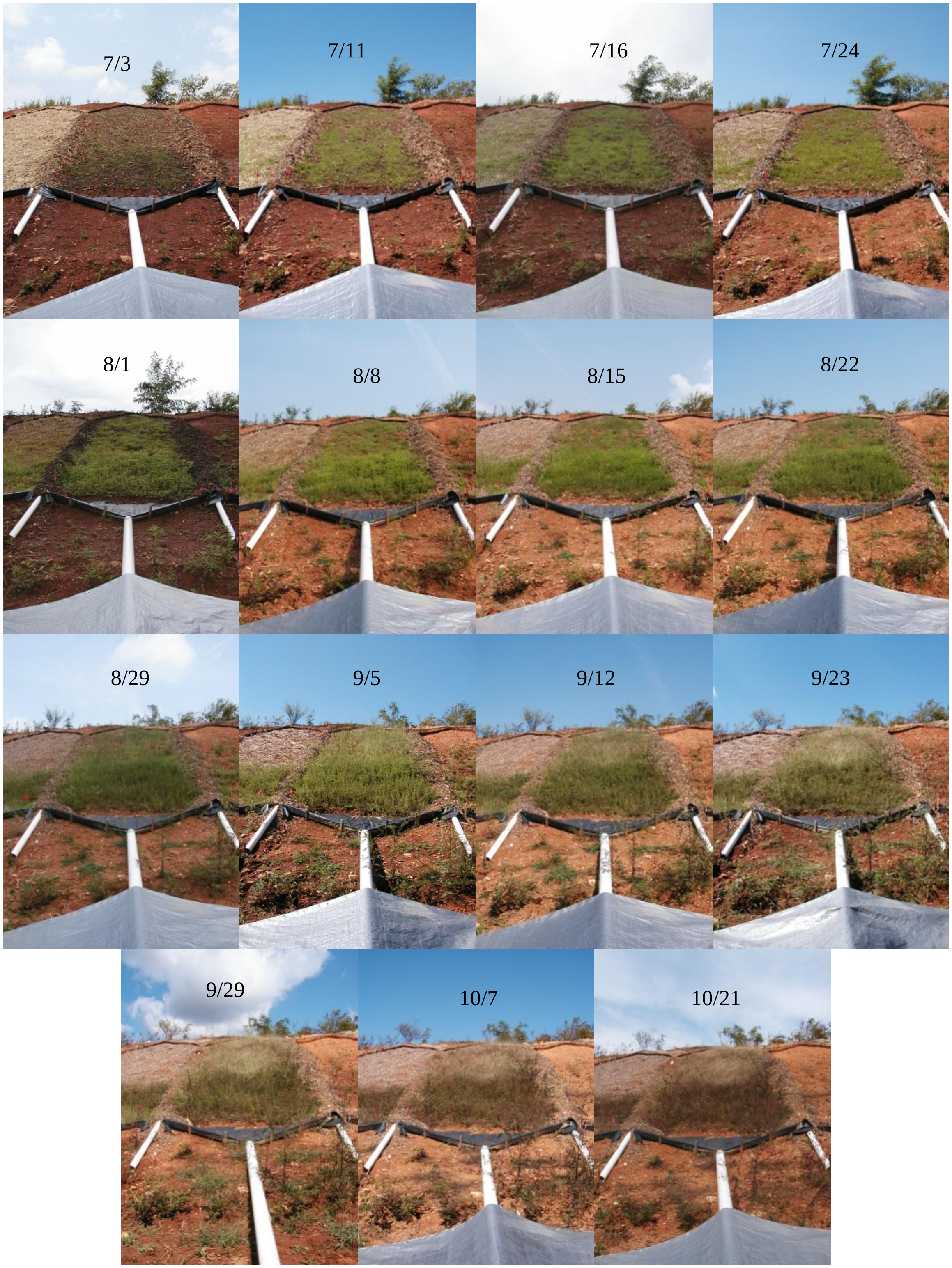
Chronological Progression of Images Captured Showing Plot 6 Treated with 50/50



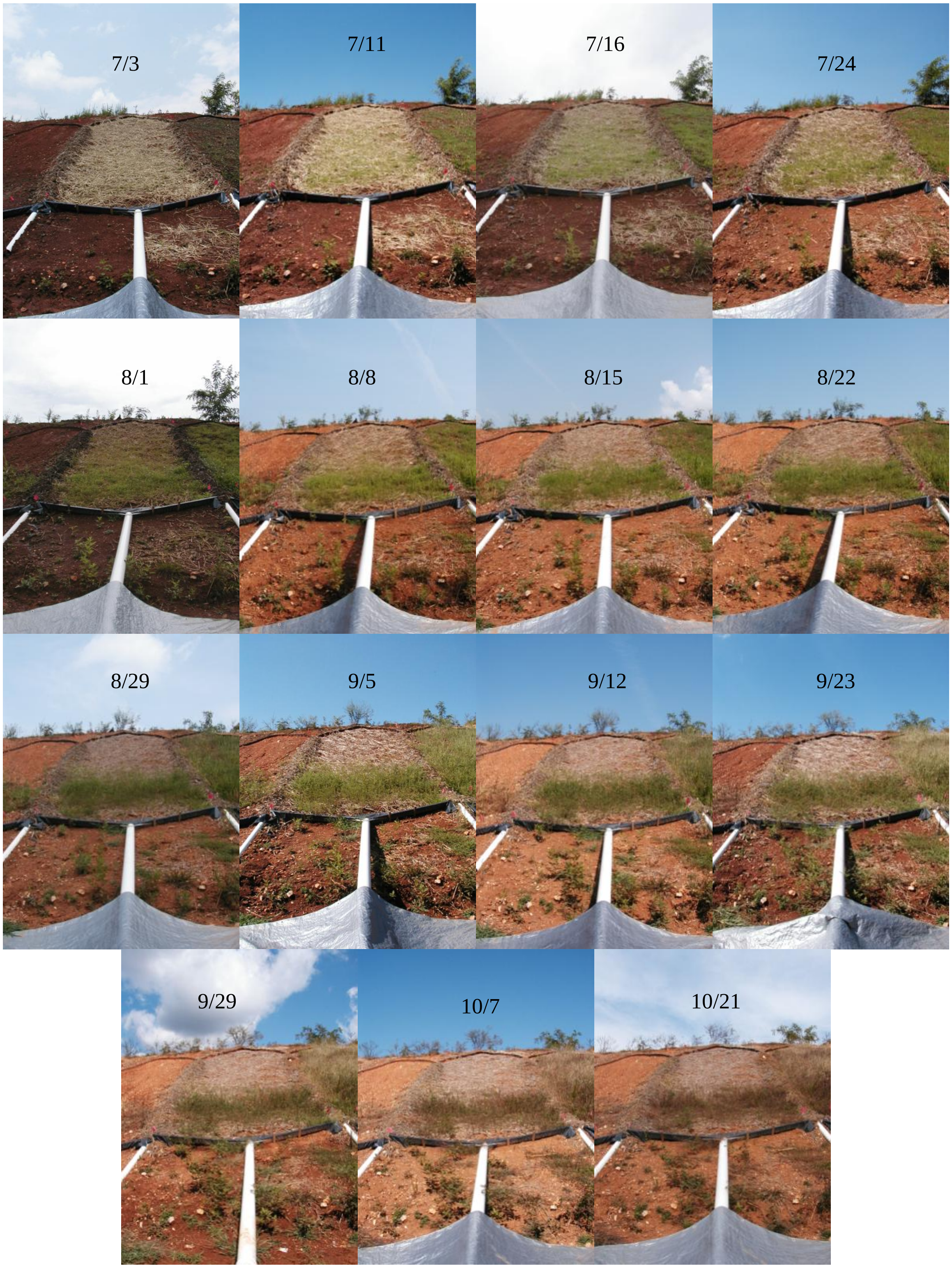
Chronological Progression of Images Captured Showing Plot 7 Treated with Straw



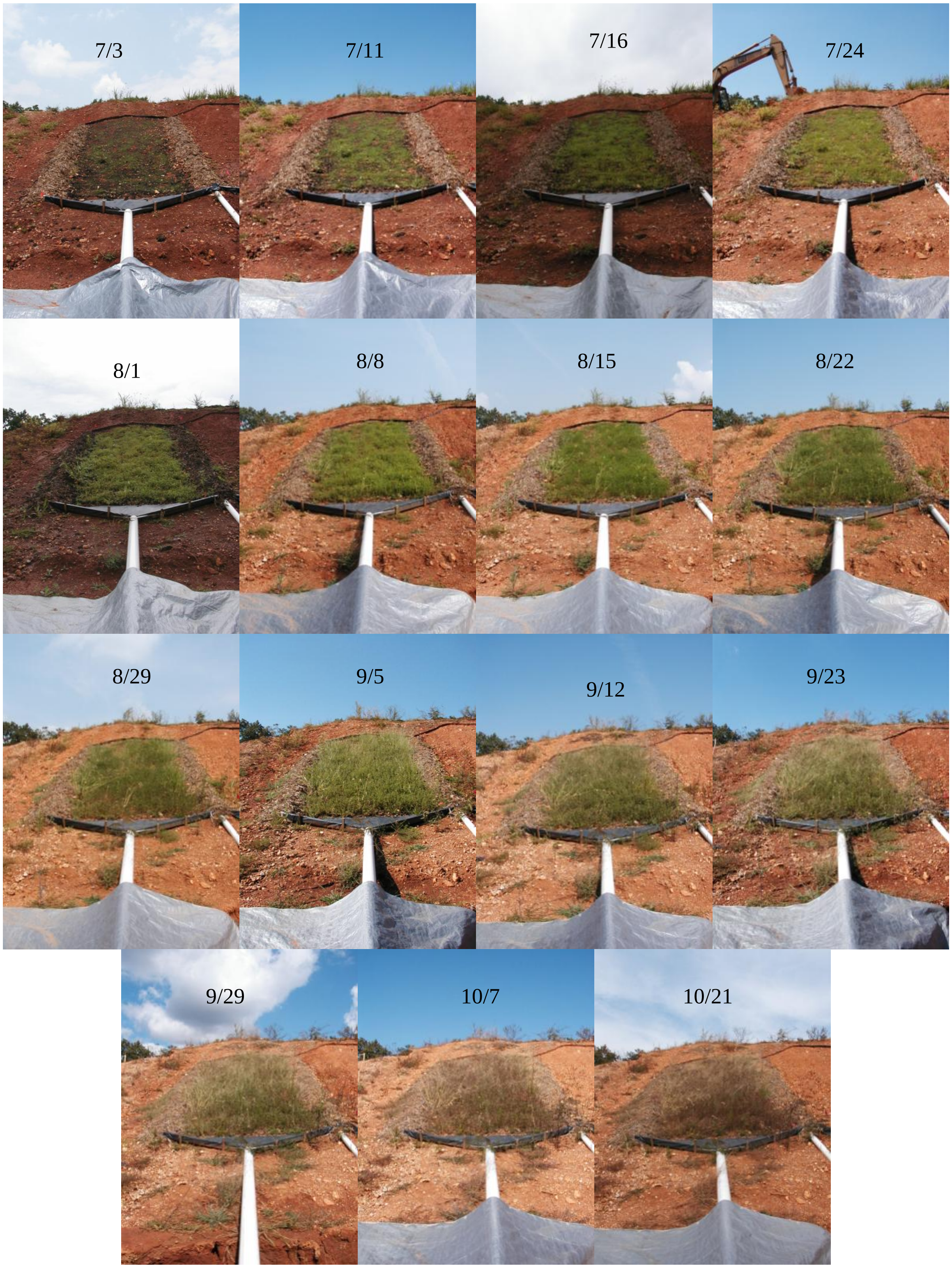
Chronological Progression of Images Captured Showing Plot 9 Treated with Straw50/50



Chronological Progression of Images Captured Showing Plot 10 Treated with Straw



Chronological Progression of Images Captured Showing Plot 12 Treated with CBS



Appendix II

Sampling Events

Sampling Event 1 – 07-02-2003
The first round of samples were impacted by two rain events with EI30s of 317.42 and 107.91 MJ*mm(ha^{-1}*h^{-1}). The remnants of Tropical Depression Bill began moving over the experiment as the collection systems were being checked, so the decision was made to wait for that storm to pass rather than collect samples while it was occurring. At least four plots are believed to have been compromised (shown in red) prior to sampling for these rain events. The actual runoff volume (determined by subtracting the amount of precipitation that fell on the collection triangles from the amount collected) calculations produced negative volumes for plots 3,7,10, and 12. These plots may have been leaking through the berms during the first two rain events. Additional earthen material and shredded wood was added to the berms following sample collection and prior to the next rain event.

Sampling Event 2 – 07-11-2003
The second round of samples were affected by a single rain event with an EI30 of 459.03 MJ*mm(ha^{-1}*h^{-1}). All three control plots were compromised during this rain event. Sediment backed up into the transfer pipe on plots 5 and 11, and the transfer pipe was clogged on plot 8. No significant differences in runoff were observed among the four treatments. The amount of sediment measured was certainly far less than what was eroded from the plot due to the fact that the collection systems for the control plots were overwhelmed.

Sampling Event 3 – 07-15-2003
The third sampling event was affected by a single rain event with an EI30 of 94.63 MJ*mm(ha^{-1}*h^{-1}). Only plot 8, a control plot, was compromised during this rain event. Sediment in the primary collection bucket was backed up into the transfer pipe. It is believed that there was considerably more sediment stuck in the transfer pipe on plot 8 than the other control plots prior to this sampling event, because the amount of sediment recovered was approximately two and a half times that of the other control plots for this sampling event.

Sampling Event 4 – 08-01-2003
This sampling event was impacted by two rain events with calculated EI30's of 108.08 and 469.07 MJ*mm(ha^{-1}*h^{-1}). The collection system was checked following the first storm and it lacked sufficient energy to cause runoff, so the sediment collected during this sampling event was eroded by the latter of the two recorded rain events. The three control plots were again overwhelmed prior to this sampling event. Sediment was backed up in the primary collection buckets to the transfer pipes.

Sampling Event 5 – 08-04-2003
The fifth round of samples were affected by a single rain event with an EI30 of 421.25 MJ*mm(ha^{-1}*h^{-1}). Half of the plots were compromised during this rain event including all of the control plots again. Plots 5,6,7,8,11, and 12 all became clogged with sediment and lost functionality at some point during the rain event. Plots 5 and 7 were also dislodged from their level positions atop their leveling triangles. Sediment was washed up to the top of the edging at the top of plots 11 and 12. The edging at the top of plot 8 became unseated appearing to allow flow from above to wash onto the plot. The berm separating plots 5 and 6 was badly damaged by this storm exposing the drain pipe buried within. The control plots were so badly damaged during this storm no effort was made to measure the sediment from their damaged collection

systems. For the purpose of running a statistical analysis an estimated sediment yield of 45000 grams was used for each of the control plots based upon the largest amount of sediment collected from a control plot in Sampling event 4 and the knowledge that the sediment yields from sampling event 5 (except plot 6) were greater than those from sampling event 4.

Sampling Event 6 – 09-01-2003

The single most powerful storm event of the experiment was observed prior this sampling event with an EI30 of 1907.09 MJ*mm(ha^{-1}*h^{-1}). Five plots were likely compromised during this storm event, the same plots compromised during the last storm event less plot 12. The drainage pipes between plots 5 and 6 and 7 became clogged and may have allowed overflow from above the plots. Sediment in the primary collection buckets of the control plots was again filled right up to the outlet of the transfer pipe as well as plots 9 and 10.

Sampling Event 7 – 09-04-2003

One storm with an EI30 of 649.14 MJ*mm(ha^{-1}*h^{-1}) affected the plots for this sampling event. Four plots were possibly compromised prior to sampling for this event. The drain pipes beneath the berms between plot 5, 6, and 7 were again clogged and may have allowed spillage over the top. Plot 11, one of the control plots, had sediment in the primary collection bucket filled up to the outlet of the transfer pipe. The decrease in the amount of damage caused by this storm indicates that the plots had become more stabilized by this point.

Sampling Event 8 – 09-23-2003

The EI30 for the storm producing these samples was 734.24 MJ*mm(ha^{-1}*h^{-1}). No damage to the plots was apparent during the collection of these samples or subsequent samples. The slope appeared to finally be stable enough for the experimental design to function as planned. The runoff volume from the straw treatment was not significantly different from the other three treatments in this round of sampling however the bare plot treatment was significantly different than the CBS and 50/50 treatments. Although this storm had a greater EI30 than the previous one, and runoff volumes for all but the 50/50 treatment, sediment yields went down considerably, further indicating increased stabilization of the slope.

Sampling Event 9 – 09-29-2003

The EI30 for the storm producing these samples was 231.13 MJ*mm(ha^{-1}*h^{-1}). As in the previous samples, the runoff volume from the straw treatment was not significantly different from the other three treatments in this round of sampling however the bare plot treatment was significantly different than the CBS and 50/50 treatments.

Sampling Event 10 – 10-15-2003

The EI30 for the storm producing these samples was 136.84 MJ*mm(ha^{-1}*h^{-1}). Runoff volume from the control plots was observed to be significantly different than that of the plots that received cover, although there were no significant differences among the plots with cover.

Sampling Event 11 – 10-31-2003

This was the least powerful storm to produce samples in the experiment with an EI30 of 18.72 MJ*mm(ha^{-1}*h^{-1}) and produced the smallest samples. There was insufficient runoff to fill the primary collection bucket of any research plot. No significant differences were observed among the four treatments for either runoff volume or sediment yield for this relatively minute round of samples.

Appendix III

Data Collected

Runoff Data

#1 07/02/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	6.1	0.5	0.3	2.1	8.9	0.4	0.0	0.5	2.8	0.0	2.8	0.2
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	14755.3	1204.5	602.3	4968.6	21530.7	1054.0	0.0	1204.5	6775.4	0.0	6624.8	451.7
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	16122.9	2572.1	1969.9	6336.3	22898.3	2421.6	1367.6	2572.1	8143.0	1367.6	7992.5	1819.3
Col. Tri. Vol.	2341.9	2258.3	2509.2	2091.0	2216.5	1923.7	2592.8	1756.4	2509.2	1421.9	2132.8	2634.7
Actual Vol.	13781.0	313.9	0.0	4245.3	20681.9	497.9	0.0	815.7	5633.8	0.0	5859.6	0.0

#2 07/11/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	9.3	4.2	5.2	6.6	13.1	6.8	3.3	3.1	2.4	3.5	13.1	2.2
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	22283.5	10087.8	12496.8	15959.8	31468.0	16411.5	7829.3	7377.7	5721.4	8431.6	31468.0	5269.8
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	23651.2	11455.4	13864.5	17327.5	32835.6	17779.1	9197.0	8745.3	7089.1	9799.2	32835.6	6637.4
Col. Tri. Vol.	1308.7	1262.0	1402.2	1168.5	1238.6	1075.0	1448.9	981.5	1402.2	794.6	1191.9	1472.3
Actual Vol.	22342.4	10193.5	12462.3	16159.0	31597.0	16704.1	7748.0	7763.7	5686.9	9004.7	31643.7	5165.1

#3 07/15/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	2.5	0.4	0.6	0.9	1.1	2.3	1.1	3.1	0.4	1.0	6.5	0.9
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	6022.6	903.4	1505.6	2107.9	2559.6	5420.3	2559.6	7377.7	1054.0	2409.0	15658.7	2107.9
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	7390.2	2271.0	2873.3	3475.5	3927.2	6787.9	3927.2	8745.3	2421.6	3776.7	17026.3	3475.5
Col. Tri. Vol.	372.0	358.7	398.5	332.1	352.0	305.5	411.8	279.0	398.5	225.8	338.7	418.4
Actual Vol.	7018.3	1912.3	2474.8	3143.4	3575.2	6482.4	3515.4	8466.3	2023.1	3550.8	16687.6	3057.1

#4 08/01/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	13.5	7.0	6.1	10.5	13.1	7.6	7.5	8.8	6.6	6.9	8.0	8.7
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	32521.9	16863.2	14755.3	25294.8	31618.5	18368.9	18067.7	21079.0	15809.3	16562.1	19272.2	20928.5
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	33889.5	18230.8	16122.9	26662.4	32986.1	19736.5	19435.4	22446.6	17176.9	17929.7	20639.9	22296.1

Col. Tri. Vol.	1563.6	1507.7	1675.3	1396.1	1479.8	1284.4	1731.1	1172.7	1675.3	949.3	1424.0	1759.0
Actual Vol.	32326.0	16723.1	14447.7	25266.4	31506.3	18452.1	17704.3	21274.0	15501.6	16980.4	19215.9	20537.1

#5 08/04/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	13.6	10.7	7.0	11.9	9.9	5.9	12.5	5.0	6.4	7.5	13.1	13.6
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	32823.0	25746.5	16863.2	28607.2	23789.2	14153.1	30112.9	12045.2	15357.6	18067.7	31468.0	32823.0
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	34190.7	27114.1	18230.8	29974.9	25156.8	15520.7	31480.5	13412.8	16725.2	19435.4	32835.6	34190.7
Col. Tri. Vol.	1226.1	1182.3	1313.6	1094.7	1160.4	1007.1	1357.4	919.5	1313.6	744.4	1116.6	1379.3
Actual Vol.	32964.6	25931.9	16917.2	28880.2	23996.4	14513.6	30123.1	12493.2	15411.6	18691.0	31719.0	32811.3

#6 09/01/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	4.5	2.8	1.9	3.3	13.1	12.9	10.5	12.9	1.4	1.4	13.6	9.6
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	10840.6	6624.8	4516.9	7829.3	31618.5	31166.8	25294.8	31016.3	3312.4	3463.0	32823.0	23186.9
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36135.5	0.0
Total Vol.	12208.3	7992.5	5884.6	9197.0	32986.1	32534.5	26662.4	32383.9	4680.0	4830.6	70326.1	24554.5
Col. Tri. Vol.	1274.3	1228.8	1365.3	1137.8	1206.0	1046.7	1410.8	955.7	1365.3	773.7	1160.5	1433.6
Actual Vol.	10934.0	6763.7	4519.3	8059.2	31780.1	31487.7	25251.6	31428.2	3314.7	4056.9	69165.6	23121.0

#7 09/04/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	4.2	4.7	3.3	1.6	10.7	10.3	5.3	6.4	2.8	7.8	13.6	4.6
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	10087.8	11292.3	7829.3	3764.1	25746.5	24692.6	12647.4	15357.6	6624.8	18820.5	32823.0	11141.8
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7227.1	0.0
Total Vol.	11455.4	12660.0	9197.0	5131.7	27114.1	26060.2	14015.0	16725.2	7992.5	20188.2	41417.8	12509.4
Col. Tri. Vol.	1274.3	1228.8	1365.3	1137.8	1206.0	1046.7	1410.8	955.7	1365.3	773.7	1160.5	1433.6
Actual Vol.	10181.2	11431.2	7831.7	3994.0	25908.1	25013.5	12604.2	15769.5	6627.2	19414.5	40257.2	11075.8

#8 09/23/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	10.1	0.8	3.6	3.4	13.1	1.9	2.1	9.9	1.5	6.6	13.6	4.4
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	24240.9	1806.8	8732.7	8281.0	31468.0	4516.9	5119.2	23789.2	3613.5	15959.8	32823.0	10539.5
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57816.7	0.0
Total Vol.	25608.5	3174.4	10100.4	9648.7	32835.6	5884.6	6486.8	25156.8	4981.2	17327.5	92007.4	11907.1

Col. Tri. Vol.	1790.9	1726.9	1918.8	1599.0	1694.9	1471.1	1982.8	1343.2	1918.8	1087.3	1631.0	2014.7
Actual Vol.	23817.6	1447.5	8181.6	8049.7	31140.6	4413.5	4504.1	23813.6	3062.4	16240.1	90376.4	9892.4

#9 09/29/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	2.1	0.1	0.4	0.6	2.6	2.4	0.3	3.4	0.4	1.4	6.4	2.5
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	5119.2	150.6	1054.0	1355.1	6323.7	5872.0	752.8	8130.5	903.4	3463.0	15357.6	6022.6
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	6486.8	1518.2	2421.6	2722.7	7691.3	7239.6	2120.4	9498.1	2271.0	4830.6	16725.2	7390.2
Col. Tri. Vol.	619.9	597.8	664.2	553.5	586.7	509.2	686.3	464.9	664.2	376.4	564.6	697.4
Actual Vol.	5866.9	920.4	1757.4	2169.2	7104.6	6730.4	1434.1	9033.2	1606.8	4454.2	16160.6	6692.8

#10 10/15/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bucket 2	2.1	1.0	0.3	0.5	4.4	1.9	1.6	5.1	0.8	1.9	5.0	1.8
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6	1367.6
Volume 2	5119.2	2409.0	602.3	1204.5	10539.5	4667.5	3914.7	12346.3	1806.8	4516.9	12045.2	4366.4
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	6486.8	3776.7	1969.9	2572.1	11907.1	6035.1	5282.3	13713.9	3174.4	5884.6	13412.8	5734.0
Col. Tri. Vol.	551.0	551.0	551.0	551.0	551.0	551.0	551.0	551.0	551.0	551.0	551.0	551.0
Actual Vol.	5935.8	3225.6	1418.8	2021.1	11356.1	5484.1	4731.3	13162.9	2623.4	5333.5	12861.7	5183.0

#11 10/31/2003

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	13.6	9.4	11.3	8.0	13.6	9.3	12.8	11.8	12.8	7.9	13.6	13.6
Bucket 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bucket 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 1	1367.6	941.0	1129.2	804.3	1367.6	928.5	1286.1	1179.4	1279.8	796.7	1367.6	1367.6
Volume 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Volume 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Vol.	1367.6	941.0	1129.2	804.3	1367.6	928.5	1286.1	1179.4	1279.8	796.7	1367.6	1367.6
Col. Tri. Vol.	454.6	454.6	454.6	454.6	454.6	454.6	454.6	454.6	454.6	454.6	454.6	454.6
Actual Vol.	913.0	486.4	674.6	349.7	913.0	473.9	831.5	724.8	825.2	342.1	913.0	913.0

Sediment Data

#1 07/02/2003 EI30= 1865 634

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	616	200	309	479	8040.5	176	460	3429.5	174.5	179	9182.5	161.5
Bucket 2												
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	616	200	309	479	8040.5	176	460	3429.5	174.5	179	9182.5	161.5
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	616	200	309	479	8040.5	176	460	3429.5	174.5	179	9182.5	161.5

#2 07/11/2003 EI30= 2697

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	734.5	667.5	1079.5	1714.5	21849.5	1207	1020.5	11084.5	1318.5	275.5	20785	868
Bucket 2												
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	734.5	667.5	1079.5	1714.5	21849.5	1207	1020.5	11084.5	1318.5	275.5	20785	868
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	734.5	667.5	1079.5	1714.5	21849.5	1207	1020.5	11084.5	1318.5	275.5	20785	868

#3 07/15/2003 EI30= 556

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	227.5	84.5	250.5	992	7257	788	222	18341	432	176.5	6085	356
Bucket 2												
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	227.5	84.5	250.5	992	7257	788	222	18341	432	176.5	6085	356
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	227.5	84.5	250.5	992	7257	788	222	18341	432	176.5	6085	356

#4 08/01/2003 EI30= 635 2756

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	982.5	1216	649.5	1947.5	23805	4974	1483	23924	1315.5	446.5	23318	633.5
Bucket 2												
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	982.5	1216	649.5	1947.5	23805	4974	1483	23924	1315.5	446.5	23318	633.5
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	982.5	1216	649.5	1947.5	23805	4974	1483	23924	1315.5	446.5	23318	633.5

#5 08/04/2003 EI30= 2475

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW

Bucket 1	1148	1230.5	1629	4055.5	NC	3860.5	5082.5	NC	4426.5	602	NC	2380
Bucket 2												
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	1148	1230.5	1629	4055.5	NC	3860.5	5082.5	NC	4426.5	602	NC	2380
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	1148	1230.5	1629	4055.5	0	3860.5	5082.5	0	4426.5	602	0	2380

#6 09/01/2003 EI30= 11205

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	518	450.5	168	487	19499	12173.45	1079.5	23747.5	638.5	563	24500	966.5
Bucket 2	3.5	4.5	0.5	5	246.5	203	31.5	1815.5	1.5	2	3071.5	22
Bucket 3	0	0	0	0		0	0	0	0	0	8.05	0
Mass 1	518	450.5	168	487	19499	12173.45	1079.5	23747.5	638.5	563	24500	966.5
Mass 2	84	108	12	120	5916	4872	756	43572	36	48	73716	528
Mass 3	0	0	0	0	0	0	0	0	0	0	4636.8	0
Total Mass	602	558.5	180	607	25415	17045.45	1835.5	67319.5	674.5	611	102852.8	1494.5

#7 09/04/2003 EI30= 3814

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	357	118	60	221	4895	3011.5	254.5	8929.2	217	258.5	14484.8	287
Bucket 2	2.7	4.5	0.65	0.9	77.95	48.3	4.85	76.5	1.25	6.05	242	5.8
Bucket 3	0	0	0	0	0	0	0	0	0	0	0.05	0
Mass 1	357	118	60	221	4895	3011.5	254.5	8929.2	217	258.5	14484.8	287
Mass 2	64.8	108	15.6	21.6	1870.8	1159.2	116.4	1836	30	145.2	5808	139.2
Mass 3	0	0	0	0	0	0	0	0	0	0	28.8	0
Total Mass	421.8	226	75.6	242.6	6765.8	4170.7	370.9	10765.2	247	403.7	20321.6	426.2

#8 09/23/2003 EI30= 4314

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	151.5	13.95	8.65	18.9	2266.5	447.45	67.05	6012.5	91.95	179.4	7645	111.15
Bucket 2	2.65	0.1	0.1	0.9	75.55	1.65	1.4	63.25	0.15	3	94.1	1.25
Bucket 3	0	0	0	0	0	0	0	0	0	0	1.45	0
Mass 1	151.5	13.95	8.65	18.9	2266.5	447.45	67.05	6012.5	91.95	179.4	7645	111.15
Mass 2	63.6	2.4	2.4	21.6	1813.2	39.6	33.6	1518	3.6	72	2258.4	30
Mass 3	0	0	0	0	0	0	0	0	0	0	835.2	0
Total Mass	215.1	16.35	11.05	40.5	4079.7	487.05	100.65	7530.5	95.55	251.4	10738.6	141.15

#9 09/29/2003 EI30= 1358

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	151.65	17.7	11.2	29.2	1944.7	240.3	60.1	5629.85	101.4	155.85	5309.45	67.15
Bucket 2	2	0.1	0.15	0.1	21.2	5.75	0.1	53	0.2	2.2	90.75	2.4
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	151.65	17.7	11.2	29.2	1944.7	240.3	60.1	5629.85	101.4	155.85	5309.45	67.15
Mass 2	48	2.4	3.6	2.4	508.8	138	2.4	1272	4.8	52.8	2178	57.6
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	199.65	20.1	14.8	31.6	2453.5	378.3	62.5	6901.85	106.2	208.65	7487.45	124.75

#10 10/15/2003 EI30= 26 804

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	134.3	18.2	10.9	17.3	750.05	141.95	35.75	4999.55	92.25	791.85	4982.05	44.25
Bucket 2	3.05	0.6	0.25	0.1	32.9	2.8	0.85	30.1	0.55	3.2	46.35	0.75
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	134.3	18.2	10.9	17.3	750.05	141.95	35.75	4999.55	92.25	791.85	4982.05	44.25
Mass 2	73.2	14.4	6	2.4	789.6	67.2	20.4	722.4	13.2	76.8	1112.4	18
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	207.5	32.6	16.9	19.7	1539.65	209.15	56.15	5721.95	105.45	868.65	6094.45	62.25

#11 10/31/2003 EI30= 110

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	4.3	1.35	0.45	0.4	217.35	3.15	1.9	20.8	2.75	2.7	52.95	3.6
Bucket 2	0	0	0	0	0	0	0	0	0	0	0	0
Bucket 3	0	0	0	0	0	0	0	0	0	0	0	0
Mass 1	4.3	1.35	0.45	0.4	217.35	3.15	1.9	20.8	2.75	2.7	52.95	3.6
Mass 2	0	0	0	0	0	0	0	0	0	0	0	0
Mass 3	0	0	0	0	0	0	0	0	0	0	0	0
Total Mass	4.3	1.35	0.45	0.4	217.35	3.15	1.9	20.8	2.75	2.7	52.95	3.6

Sediment Back Calculation Factors

#6	0.67%	0.99%	0.30%	1.02%	1.25%	1.64%	2.84%	7.10%	0.23%	0.35%	11.14%	2.23%
#7	0.75%	3.67%	1.07%	0.41%	1.57%	1.58%	1.87%	0.85%	0.57%	2.29%	1.64%	1.98%
#8	1.72%	0.71%	1.14%	4.55%	3.23%	0.37%	2.05%	1.04%	0.16%	1.64%	1.22%	1.11%
#9	1.30%	0.56%	1.32%	0.34%	1.08%	2.34%	0.17%	0.93%	0.20%	1.39%	1.68%	3.45%
#10	2.22%	3.19%	2.24%	0.57%	4.20%	1.93%	2.32%	0.60%	0.59%	0.40%	0.92%	1.67%
Avg.	1.33%	1.83%	1.22%	1.38%	2.26%	1.57%	1.85%	2.10%	0.35%	1.22%	3.32%	2.09%

Estimated Sediment Collected in First Five Events

#1 07/02/2003 EI30= 1865 634

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	607.79	196.35	305.25	472.41	7858.43	173.23	451.50	3357.32	173.89	176.82	8877.61	158.13
Bucket 2	8.21	3.65	3.75	6.59	182.07	2.77	8.50	72.18	0.61	2.18	304.89	3.37
Bucket 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass 1	607.79	196.35	305.25	472.41	7858.43	173.23	451.50	3357.32	173.89	176.82	8877.61	158.13
Mass 2	197.02	87.62	90.11	158.26	4369.70	66.38	204.00	1732.36	14.74	52.24	7317.30	80.90
Mass 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass	804.81	283.97	395.35	630.67	12228.13	239.61	655.50	5089.68	188.62	229.06	16194.91	239.03

#2 07/11/2003 EI30= 2697

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	724.71	655.31	1066.38	1690.90	21354.73	1188.03	1001.64	10851.20	1313.86	272.15	20094.87	849.88
Bucket 2	9.79	12.19	13.12	23.60	494.77	18.97	18.86	233.30	4.64	3.35	690.13	18.12
Bucket 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass 1	724.71	655.31	1066.38	1690.90	21354.73	1188.03	1001.64	10851.20	1313.86	272.15	20094.87	849.88
Mass 2	234.92	292.45	314.79	566.47	11874.36	455.23	452.57	5599.16	111.36	80.40	16563.03	434.81

Mass 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass	959.63	947.76	1381.17	2257.37	33229.10	1643.26	1454.21	16450.36	1425.22	352.55	36657.91	1284.69

#3 07/15/2003 EI30= 556

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	224.47	82.96	247.46	978.34	7092.67	775.62	217.90	17954.97	430.48	174.35	5882.96	348.57
Bucket 2	3.03	1.54	3.04	13.66	164.33	12.38	4.10	386.03	1.52	2.15	202.04	7.43
Bucket 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass 1	224.47	82.96	247.46	978.34	7092.67	775.62	217.90	17954.97	430.48	174.35	5882.96	348.57
Mass 2	72.76	37.02	73.05	327.76	3943.90	297.20	98.45	9264.67	36.49	51.51	4848.98	178.33
Mass 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass	297.23	119.98	320.50	1306.10	11036.57	1072.82	316.35	27219.64	466.96	225.86	10731.94	526.90

#4 08/01/2003 EI30= 635 2756

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	969.41	1193.80	641.61	1920.69	23265.95	4895.83	1455.60	23420.47	1310.87	441.07	22543.77	620.28
Bucket 2	13.09	22.20	7.89	26.81	539.05	78.17	27.40	503.53	4.63	5.43	774.23	13.22
Bucket 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mass 1	969.41	1193.80	641.61	1920.69	23265.95	4895.83	1455.60	23420.47	1310.87	441.07	22543.77	620.28
Mass 2	314.23	532.75	189.40	643.45	12937.10	1875.98	657.68	12084.83	111.10	130.31	18581.52	317.34
Mass 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Mass	1283.64	1726.56	831.00	2564.14	36203.06	6771.81	2113.28	35505.30	1421.97	571.38	41125.29	937.62

#5 08/04/2003 EI30= 2475

Plot	1	2	3	4	5	6	7	8	9	10	11	12
Treatment	Straw	50/50	CMW	CMW	Control	50/50	Straw	Control	50/50	Straw	Control	CMW
Bucket 1	1132.70	1208.04	1609.21	3999.67		3799.83	4988.58		4410.92	594.68		2330.32
Bucket 2	15.30	22.46	19.79	55.83		60.67	93.92		15.58	7.32		49.68
Bucket 3	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00
Mass 1	1132.70	1208.04	1609.21	3999.67		3799.83	4988.58		4410.92	594.68		2330.32
Mass 2	367.17	539.11	475.02	1339.93		1456.02	2253.98		373.84	175.69		1192.21
Mass 3	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00
Total Mass	1499.87	1747.14	2084.23	5339.60		5255.85	7242.57		4784.77	770.37		3522.53

Sediment Totals

Summary grams

Event	1	2	3	4	5	6	7	8	9	10	11	12
1	804.8	284.0	395.4	630.7	12228.1	239.6	655.5	5089.7	188.6	229.1	16194.9	239.0
2	959.6	947.8	1381.2	2257.4	33229.1	1643.3	1454.2	16450.4	1425.2	352.6	36657.9	1284.7
3	297.2	120.0	320.5	1306.1	11036.6	1072.8	316.4	27219.6	467.0	225.9	10731.9	526.9
4	1283.6	1726.6	831.0	2564.1	36203.1	6771.8	2113.3	35505.3	1422.0	571.4	41125.3	937.6
5	1499.9	1747.1	2084.2	5339.6	45000.0	5255.8	7242.6	45000.0	4784.8	770.4	45000.0	3522.5
6	602.0	558.5	180.0	607.0	25415.0	17045.5	1835.5	67319.5	674.5	611.0	102852.8	1494.5
7	421.8	226.0	75.6	242.6	6765.8	4170.7	370.9	10765.2	247.0	403.7	20321.6	426.2
8	215.1	16.4	11.1	40.5	4079.7	487.1	100.7	7530.5	95.6	251.4	10738.6	141.2
9	199.7	20.1	14.8	31.6	2453.5	378.3	62.5	6901.9	106.2	208.7	7487.5	124.8
10	207.5	32.6	16.9	19.7	1539.7	209.2	56.2	5722.0	105.5	868.7	6094.5	62.3

11	4.3	1.4	0.5	0.4	217.4	3.2	1.9	20.8	2.8	2.7	53.0	3.6
Total	6495.5	5680.3	5311.1	13039.7	178167.9	37277.2	14209.5	227524.8	9519.0	4495.3	297257.9	8763.2

Summary kg

Event	1	2	3	4	5	6	7	8	9	10	11	12
1	0.80	0.28	0.40	0.63	12.23	0.24	0.66	5.09	0.19	0.23	16.19	0.24
2	0.96	0.95	1.38	2.26	33.23	1.64	1.45	16.45	1.43	0.35	36.66	1.28
3	0.30	0.12	0.32	1.31	11.04	1.07	0.32	27.22	0.47	0.23	10.73	0.53
4	1.28	1.73	0.83	2.56	36.20	6.77	2.11	35.51	1.42	0.57	41.13	0.94
5	1.50	1.75	2.08	5.34	45.00	5.26	7.24	45.00	4.78	0.77	45.00	3.52
6	0.60	0.56	0.18	0.61	25.42	17.05	1.84	67.32	0.67	0.61	102.85	1.49
7	0.42	0.23	0.08	0.24	6.77	4.17	0.37	10.77	0.25	0.40	20.32	0.43
8	0.22	0.02	0.01	0.04	4.08	0.49	0.10	7.53	0.10	0.25	10.74	0.14
9	0.20	0.02	0.01	0.03	2.45	0.38	0.06	6.90	0.11	0.21	7.49	0.12
10	0.21	0.03	0.02	0.02	1.54	0.21	0.06	5.72	0.11	0.87	6.09	0.06
11	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.02	0.00	0.00	0.05	0.00
Total	6.50	5.68	5.31	13.04	178.17	37.28	14.21	227.52	9.52	4.50	297.26	8.76

Appendix IV

Storm Data

Event	Date	Max 30	MJ*mm/ha*hr	hundred ft*tonf*in/acre*hr
1a	27-Jun	1.65	317.4	18.7
1b	2-Jul	0.41	107.9	6.3
2	11-Jul	1.47	459.0	27.0
3	15-Jul	0.96	94.6	5.6
4a	29-Jul	1.14	108.1	6.4
4b	1-Aug	1.44	469.1	27.6
5	4-Aug	1.74	421.2	24.8
6	1-Sep	3.97	1907.1	112.1
7	4-Sep	2.00	649.1	38.1
8	23-Sep	1.79	734.2	43.1
9	29-Sep	1.44	231.1	13.6
10	15-Oct	1.05	136.8	8.0
11	31-Oct	0.25	18.7	1.1

Hr/Min	Ptemp	mm	in.	iph	u.en.	T.en.	max 30
2300	24.20	2.24	0.08819	0.35276	593.44750	52.33553	
2315	23.02	6.16	0.24252	0.97008	868.17684	210.54997	
2330	22.26	14.84	0.58425	2.33701	1058.32344	618.32756	1.65354
2345	21.67	5.60	0.22047	0.88189	840.82132	185.37793	
0	21.13	0.98	0.03858	0.15433	448.55816	17.30657	
15	20.78	0.14	0.00551	0.02205	329.56853	1.81652	
30	20.63	0.00	0.00000	0.00000	307.72000	0.00000	
45	20.58	0.14	0.00551	0.02205	329.56853	1.81652	
100	20.54	0.00	0.00000	0.00000	307.72000	0.00000	
115	20.41	0.00	0.00000	0.00000	307.72000	0.00000	
130	20.26	0.00	0.00000	0.00000	307.72000	0.00000	
145	20.14	0.00	0.00000	0.00000	307.72000	0.00000	
200	20.10	0.00	0.00000	0.00000	307.72000	0.00000	
215	20.10	0.00	0.00000	0.00000	307.72000	0.00000	
230	20.10	0.00	0.00000	0.00000	307.72000	0.00000	
245	20.06	0.00	0.00000	0.00000	307.72000	0.00000	
300	20.06	0.00	0.00000	0.00000	307.72000	0.00000	
315	20.10	0.00	0.00000	0.00000	307.72000	0.00000	
330	20.18	0.00	0.00000	0.00000	307.72000	0.00000	
345	20.18	0.00	0.00000	0.00000	307.72000	0.00000	
400	20.16	0.00	0.00000	0.00000	307.72000	0.00000	
415	20.20	0.00	0.00000	0.00000	307.72000	0.00000	
430	20.30	0.00	0.00000	0.00000	307.72000	0.00000	
445	20.36	0.00	0.00000	0.00000	307.72000	0.00000	
500	20.39	0.00	0.00000	0.00000	307.72000	0.00000	
515	20.39	0.00	0.00000	0.00000	307.72000	0.00000	
530	20.36	0.00	0.00000	0.00000	307.72000	0.00000	
545	20.28	0.00	0.00000	0.00000	307.72000	0.00000	
600	20.08	0.00	0.00000	0.00000	307.72000	0.00000	
615	19.98	0.00	0.00000	0.00000	307.72000	0.00000	
630	19.92	0.14	0.00551	0.02205	329.56853	1.81652	
645	19.89	0.00	0.00000	0.00000	307.72000	0.00000	
700	19.86	0.28	0.01102	0.04409	350.81379	3.86724	
715	19.81	0.70	0.02756	0.11024	411.09422	11.32937	
730	19.75	0.42	0.01654	0.06614	371.47244	6.14246	
745	19.62	0.14	0.00551	0.02205	329.56853	1.81652	
800	19.57	0.28	0.01102	0.04409	350.81379	3.86724	
815	19.65	0.28	0.01102	0.04409	350.81379	3.86724	

830	19.77	0.28	0.01102	0.04409	350.81379	3.86724	
845	19.74	0.28	0.01102	0.04409	350.81379	3.86724	
900	19.49	0.00				1127.97166	
915	19.21	0.00			Max.I30=	1.65354	
930	19.07	0.00			EI30=	18.65150	#1A
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**
1230	24.36	0.28	0.01102	0.04409	350.81379	3.86724	
1245	23.36	0.00	0.00000	0.00000	307.72000	0.00000	
1300	23.09	0.00	0.00000	0.00000	307.72000	0.00000	
1315	23.21	0.00	0.00000	0.00000	307.72000	0.00000	
1330	23.36	0.00	0.00000	0.00000	307.72000	0.00000	
1345	23.53	0.00	0.00000	0.00000	307.72000	0.00000	
1400	23.61	0.00	0.00000	0.00000	307.72000	0.00000	
1415	24.06	0.00	0.00000	0.00000	307.72000	0.00000	
1430	24.47	0.00	0.00000	0.00000	307.72000	0.00000	
1445	24.71	0.00	0.00000	0.00000	307.72000	0.00000	
1500	25.17	0.00	0.00000	0.00000	307.72000	0.00000	
1515	25.64	0.00	0.00000	0.00000	307.72000	0.00000	
1530	25.38	0.00	0.00000	0.00000	307.72000	0.00000	
1545	24.77	0.00	0.00000	0.00000	307.72000	0.00000	
1600	24.14	0.00	0.00000	0.00000	307.72000	0.00000	
1615	23.92	0.00	0.00000	0.00000	307.72000	0.00000	
1630	24.02	0.00	0.00000	0.00000	307.72000	0.00000	
1645	24.11	0.00	0.00000	0.00000	307.72000	0.00000	
1700	24.14	0.00	0.00000	0.00000	307.72000	0.00000	
1715	24.16	0.00	0.00000	0.00000	307.72000	0.00000	
1730	24.14	0.00	0.00000	0.00000	307.72000	0.00000	
1745	24.06	0.00	0.00000	0.00000	307.72000	0.00000	
1800	23.94	0.00	0.00000	0.00000	307.72000	0.00000	
1815	23.78	0.00	0.00000	0.00000	307.72000	0.00000	
1830	23.68	0.00	0.00000	0.00000	307.72000	0.00000	
1845	23.71	0.00	0.00000	0.00000	307.72000	0.00000	
1900	23.80	0.00	0.00000	0.00000	307.72000	0.00000	
1915	23.79	0.00	0.00000	0.00000	307.72000	0.00000	
1930	23.62	0.00	0.00000	0.00000	307.72000	0.00000	
1945	23.40	0.00	0.00000	0.00000	307.72000	0.00000	
2000	23.12	0.00	0.00000	0.00000	307.72000	0.00000	
2015	22.80	0.00	0.00000	0.00000	307.72000	0.00000	
2030	22.48	0.14	0.00551	0.02205	329.56853	1.81652	
2045	22.20	0.00	0.00000	0.00000	307.72000	0.00000	
2100	21.97	0.00	0.00000	0.00000	307.72000	0.00000	
2115	21.81	0.00	0.00000	0.00000	307.72000	0.00000	
2130	21.71	0.00	0.00000	0.00000	307.72000	0.00000	
2145	21.64	0.00	0.00000	0.00000	307.72000	0.00000	
2200	21.58	0.00	0.00000	0.00000	307.72000	0.00000	
2215	21.57	0.00	0.00000	0.00000	307.72000	0.00000	
2230	21.59	0.00	0.00000	0.00000	307.72000	0.00000	
2245	21.56	0.14	0.00551	0.02205	329.56853	1.81652	
2300	20.86	3.08	0.12126	0.48504	671.62926	81.44166	
2315	19.97	2.10	0.08268	0.33071	579.09199	47.87768	0.40787
2330	19.47	0.98	0.03858	0.15433	448.55816	17.30657	
2345	19.19	0.70	0.02756	0.11024	411.09422	11.32937	
0	19.03	0.14	0.00551	0.02205	329.56853	1.81652	
15	18.92	0.14	0.00551	0.02205	329.56853	1.81652	
30	18.84	0.00	0.00000	0.00000	307.72000	0.00000	
45	18.83	0.00	0.00000	0.00000	307.72000	0.00000	

100	18.81	0.14	0.00551	0.02205	329.56853	1.81652
115	18.81	0.00	0.00000	0.00000	307.72000	0.00000
130	18.80	0.00	0.00000	0.00000	307.72000	0.00000
145	18.75	0.00	0.00000	0.00000	307.72000	0.00000
200	18.66	0.00	0.00000	0.00000	307.72000	0.00000
215	18.55	0.00	0.00000	0.00000	307.72000	0.00000
230	18.43	0.00	0.00000	0.00000	307.72000	0.00000
245	18.36	0.00	0.00000	0.00000	307.72000	0.00000
300	18.36	0.00	0.00000	0.00000	307.72000	0.00000
315	18.35	0.14	0.00551	0.02205	329.56853	1.81652
330	18.31	0.00	0.00000	0.00000	307.72000	0.00000
345	18.25	0.00	0.00000	0.00000	307.72000	0.00000
400	18.20	0.00	0.00000	0.00000	307.72000	0.00000
415	18.18	0.14	0.00551	0.02205	329.56853	1.81652
430	18.26	0.00	0.00000	0.00000	307.72000	0.00000
445	18.43	0.00	0.00000	0.00000	307.72000	0.00000
500	18.56	0.00	0.00000	0.00000	307.72000	0.00000
515	18.65	0.28	0.01102	0.04409	350.81379	3.86724
530	18.72	0.28	0.01102	0.04409	350.81379	3.86724
545	18.76	0.14	0.00551	0.02205	329.56853	1.81652
600	18.80	0.28	0.01102	0.04409	350.81379	3.86724
615	18.84	0.56	0.02205	0.08819	391.56066	8.63283
630	18.85	0.42	0.01654	0.06614	371.47244	6.14246
645	18.87	0.28	0.01102	0.04409	350.81379	3.86724
700	18.89	0.42	0.01654	0.06614	371.47244	6.14246
715	18.92	0.42	0.01654	0.06614	371.47244	6.14246
730	18.93	0.14	0.00551	0.02205	329.56853	1.81652
745	18.97	0.28	0.01102	0.04409	350.81379	3.86724
800	19.06	0.28	0.01102	0.04409	350.81379	3.86724
815	19.16	0.14	0.00551	0.02205	329.56853	1.81652
830	19.28	0.42	0.01654	0.06614	371.47244	6.14246
845	19.40	0.28	0.01102	0.04409	350.81379	3.86724
900	19.52	0.14	0.00551	0.02205	329.56853	1.81652
915	19.64	0.28	0.01102	0.04409	350.81379	3.86724
930	19.74	0.28	0.01102	0.04409	350.81379	3.86724
945	19.85	0.42	0.01654	0.06614	371.47244	6.14246
1000	19.94	0.28	0.01102	0.04409	350.81379	3.86724
1015	20.01	0.14	0.00551	0.02205	329.56853	1.81652
1030	20.11	0.42	0.01654	0.06614	371.47244	6.14246
1045	20.25	0.42	0.01654	0.06614	371.47244	6.14246
1100	20.44	0.28	0.01102	0.04409	350.81379	3.86724
1115	20.59	0.42	0.01654	0.06614	371.47244	6.14246
1130	20.72	0.14	0.00551	0.02205	329.56853	1.81652
1145	20.84	0.14	0.00551	0.02205	329.56853	1.81652
1200	20.81	0.70	0.02756	0.11024	411.09422	11.32937
1215	20.78	0.28	0.01102	0.04409	350.81379	3.86724
1230	20.82	0.00	0.00000	0.00000	307.72000	0.00000
1245	20.93	0.14	0.00551	0.02205	329.56853	1.81652
1300	21.20	0.14	0.00551	0.02205	329.56853	1.81652
1315	21.62	0.00	0.00000	0.00000	307.72000	0.00000
1330	22.01	0.00	0.00000	0.00000	307.72000	0.00000
1345	22.09	0.14	0.00551	0.02205	329.56853	1.81652
1400	21.94	0.00	0.00000	0.00000	307.72000	0.00000
1415	21.87	0.00	0.00000	0.00000	307.72000	0.00000
1430	21.94	0.14	0.00551	0.02205	329.56853	1.81652
1445	21.87	0.14	0.00551	0.02205	329.56853	1.81652

1500	21.78	0.14	0.00551	0.02205	329.56853	1.81652
1515	21.61	0.42	0.01654	0.06614	371.47244	6.14246
1530	21.36	0.84	0.03307	0.13228	430.08842	14.22340
1545	21.13	0.56	0.02205	0.08819	391.56066	8.63283
1600	21.01	0.14	0.00551	0.02205	329.56853	1.81652
1615	20.91	0.28	0.01102	0.04409	350.81379	3.86724
1630	20.83	0.28	0.01102	0.04409	350.81379	3.86724
1645	20.82	0.42	0.01654	0.06614	371.47244	6.14246
1700	20.74	0.14	0.00551	0.02205	329.56853	1.81652
1715	20.62	0.28	0.01102	0.04409	350.81379	3.86724
1730	20.56	0.14	0.00551	0.02205	329.56853	1.81652
1745	20.52	0.14	0.00551	0.02205	329.56853	1.81652
1800	20.51	0.84	0.03307	0.13228	430.08842	14.22340
1815	20.51	0.28	0.01102	0.04409	350.81379	3.86724
1830	20.45	0.14	0.00551	0.02205	329.56853	1.81652
1845	20.40	0.28	0.01102	0.04409	350.81379	3.86724
1900	20.36	0.56	0.02205	0.08819	391.56066	8.63283
1915	20.27	0.42	0.01654	0.06614	371.47244	6.14246
1930	20.13	0.84	0.03307	0.13228	430.08842	14.22340
1945	19.97	1.40	0.05512	0.22047	500.96344	27.61216
2000	19.77	1.54	0.06063	0.24252	517.47621	31.37454
2015	19.58	1.40	0.05512	0.22047	500.96344	27.61216
2030	19.39	1.54	0.06063	0.24252	517.47621	31.37454
2045	19.21	2.24	0.08819	0.35276	593.44750	52.33553
2100	19.06	1.40	0.05512	0.22047	500.96344	27.61216
2115	18.91	0.84	0.03307	0.13228	430.08842	14.22340
2130	18.77	0.84	0.03307	0.13228	430.08842	14.22340
2145	18.66	0.42	0.01654	0.06614	371.47244	6.14246
2200	18.56	0.14	0.00551	0.02205	329.56853	1.81652
2215	18.48	0.14	0.00551	0.02205	329.56853	1.81652
2230	18.40	0.28	0.01102	0.04409	350.81379	3.86724
2245	18.36	0.84	0.03307	0.13228	430.08842	14.22340
2300	18.36	0.28	0.01102	0.04409	350.81379	3.86724
2315	18.37	0.84	0.03307	0.13228	430.08842	14.22340
2330	18.40	1.12	0.04409	0.17638	466.51792	20.57087
2345	18.43	0.70	0.02756	0.11024	411.09422	11.32937
0	18.43	2.94	0.11575	0.46299	659.49377	76.33511
15	18.41	1.40	0.05512	0.22047	500.96344	27.61216
30	18.37	2.94	0.11575	0.46299	659.49377	76.33511
45	18.36	1.96	0.07717	0.30866	564.32885	43.54664
100	18.36	1.68	0.06614	0.26457	533.53303	35.28880
115	18.38	1.68	0.06614	0.26457	533.53303	35.28880
130	18.37	0.84	0.03307	0.13228	430.08842	14.22340
145	18.33	0.56	0.02205	0.08819	391.56066	8.63283
200	18.27	1.26	0.04961	0.19843	483.98178	24.00855
215	18.22	0.42	0.01654	0.06614	371.47244	6.14246
230	18.20	1.68	0.06614	0.26457	533.53303	35.28880
245	18.19	1.68	0.06614	0.26457	533.53303	35.28880
300	18.19	1.12	0.04409	0.17638	466.51792	20.57087
315	18.20	0.98	0.03858	0.15433	448.55816	17.30657
330	18.22	1.26	0.04961	0.19843	483.98178	24.00855
345	18.20	0.56	0.02205	0.08819	391.56066	8.63283
400	18.17	1.40	0.05512	0.22047	500.96344	27.61216
415	18.13	1.82	0.07165	0.28661	549.14650	39.34829
430	18.08	2.66	0.10472	0.41890	634.17923	66.41405
445	18.04	0.84	0.03307	0.13228	430.08842	14.22340

500	18.03	1.54	0.06063	0.24252	517.47621		31.37454	
515	17.99	1.12	0.04409	0.17638	466.51792		20.57087	
530	17.93	0.14	0.00551	0.02205	329.56853		1.81652	
545	17.89	1.26	0.04961	0.19843	483.98178		24.00855	
600	17.89	0.70	0.02756	0.11024	411.09422		11.32937	
615	17.92	0.42	0.01654	0.06614	371.47244		6.14246	
630	17.93	0.56	0.02205	0.08819	391.56066		8.63283	
645	17.94	0.56	0.02205	0.08819	391.56066		8.63283	
700	17.93	0.14	0.00551	0.02205	329.56853		1.81652	
715	17.93	0.42	0.01654	0.06614	371.47244		6.14246	
730	17.93	0.84	0.03307	0.13228	430.08842		14.22340	
745	17.93	1.26	0.04961	0.19843	483.98178		24.00855	
800	17.96	0.70	0.02756	0.11024	411.09422		11.32937	
815	18.02	0.28	0.01102	0.04409	350.81379		3.86724	
830	18.11	0.14	0.00551	0.02205	329.56853		1.81652	
845	18.20	0.00	0.00000	0.00000	307.72000		0.00000	
900	18.29	0.14	0.00551	0.02205	329.56853		1.81652	
915	18.39	0.14	0.00551	0.02205	329.56853		1.81652	
930	18.60	0.28	0.01102	0.04409	350.81379		3.86724	
945	18.88	0.14	0.00551	0.02205	329.56853		1.81652	
1000	19.19	0.00	0.00000	0.00000	307.72000		0.00000	
1015	19.37	0.00	0.00000	0.00000	307.72000		0.00000	
1030	19.39	0.28	0.01102	0.04409	350.81379		3.86724	
1045	19.60	0.14	0.00551	0.02205	329.56853		1.81652	
1100	19.91	0.00	0.00000	0.00000	307.72000		0.00000	
1115	20.29	0.00	0.00000	0.00000	307.72000		0.00000	
1130	21.03	0.00	0.00000	0.00000	307.72000		0.00000	
1145	21.55	0.28	0.01102	0.04409	350.81379		3.86724	
1200	21.54	0.00					1555.35650	
1215	21.74	0.00			Max.I30=		0.40787	
1230	22.55	0.00			EI30=		6.34390	#1B
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**		**max 30**
1630	28.60	0.84	0.03307	0.13228	430.08842		14.22340	
1645	27.51	0.98	0.03858	0.15433	448.55816		17.30657	
1700	26.08	3.22	0.12677	0.50709	683.42966		86.63951	
1715	25.00	0.00	0.00000	0.00000	307.72000		0.00000	
1730	24.72	0.00	0.00000	0.00000	307.72000		0.00000	
1745	24.78	0.00	0.00000	0.00000	307.72000		0.00000	
1800	25.07	0.00	0.00000	0.00000	307.72000		0.00000	
1815	25.75	0.00	0.00000	0.00000	307.72000		0.00000	
1830	27.04	0.00	0.00000	0.00000	307.72000		0.00000	
1845	28.04	0.00	0.00000	0.00000	307.72000		0.00000	
1900	28.86	0.00	0.00000	0.00000	307.72000		0.00000	
1915	28.77	0.00	0.00000	0.00000	307.72000		0.00000	
1930	27.83	1.40	0.05512	0.22047	500.96344		27.61216	
1945	25.93	6.02	0.23701	0.94803	861.62246		204.21131	
2000	24.38	0.28	0.01102	0.04409	350.81379		3.86724	
2015	23.44	0.42	0.01654	0.06614	371.47244		6.14246	
2030	22.83	0.84	0.03307	0.13228	430.08842		14.22340	
2045	22.44	0.00	0.00000	0.00000	307.72000		0.00000	
2100	22.12	0.00	0.00000	0.00000	307.72000		0.00000	
2115	21.99	0.14	0.00551	0.02205	329.56853		1.81652	
2130	22.08	0.00	0.00000	0.00000	307.72000		0.00000	
2145	22.05	3.78	0.14882	0.59528	727.46172		108.26005	
2200	21.87	10.64	0.41890	1.67559	1004.77817		420.89920	
2215	21.60	1.12	0.04409	0.17638	466.51792		20.57087	

2230	21.42	0.14	0.00551	0.02205	329.56853	1.81652
2245	21.22	0.00	0.00000	0.00000	307.72000	0.00000
2300	21.02	0.00	0.00000	0.00000	307.72000	0.00000
2315	20.85	0.00	0.00000	0.00000	307.72000	0.00000
2330	20.72	0.00	0.00000	0.00000	307.72000	0.00000
2345	20.62	0.00	0.00000	0.00000	307.72000	0.00000
0	20.52	0.00	0.00000	0.00000	307.72000	0.00000
15	20.44	0.00	0.00000	0.00000	307.72000	0.00000
30	20.44	0.00	0.00000	0.00000	307.72000	0.00000
45	20.36	0.00	0.00000	0.00000	307.72000	0.00000
100	20.42	0.00	0.00000	0.00000	307.72000	0.00000
115	20.62	0.00	0.00000	0.00000	307.72000	0.00000
130	20.78	0.00	0.00000	0.00000	307.72000	0.00000
145	20.81	0.00	0.00000	0.00000	307.72000	0.00000
200	20.75	0.00	0.00000	0.00000	307.72000	0.00000
215	20.47	0.00	0.00000	0.00000	307.72000	0.00000
230	20.37	0.00	0.00000	0.00000	307.72000	0.00000
245	20.49	0.00	0.00000	0.00000	307.72000	0.00000
300	20.55	0.00	0.00000	0.00000	307.72000	0.00000
315	20.46	0.00	0.00000	0.00000	307.72000	0.00000
330	20.33	0.00	0.00000	0.00000	307.72000	0.00000
345	20.26	0.00	0.00000	0.00000	307.72000	0.00000
400	20.26	0.00	0.00000	0.00000	307.72000	0.00000
415	20.27	0.00	0.00000	0.00000	307.72000	0.00000
430	20.31	0.00	0.00000	0.00000	307.72000	0.00000
445	20.38	0.00	0.00000	0.00000	307.72000	0.00000
500	20.44	0.00	0.00000	0.00000	307.72000	0.00000
515	20.45	0.00	0.00000	0.00000	307.72000	0.00000
530	20.48	0.00	0.00000	0.00000	307.72000	0.00000
545	20.56	0.00	0.00000	0.00000	307.72000	0.00000
600	20.62	0.00	0.00000	0.00000	307.72000	0.00000
615	20.70	0.00	0.00000	0.00000	307.72000	0.00000
630	20.76	0.00	0.00000	0.00000	307.72000	0.00000
645	20.84	0.14	0.00551	0.02205	329.56853	1.81652
700	20.98	0.00	0.00000	0.00000	307.72000	0.00000
715	21.10	0.00	0.00000	0.00000	307.72000	0.00000
730	21.18	0.00	0.00000	0.00000	307.72000	0.00000
745	21.29	0.00	0.00000	0.00000	307.72000	0.00000
800	21.44	0.00	0.00000	0.00000	307.72000	0.00000
815	21.68	0.00	0.00000	0.00000	307.72000	0.00000
830	21.81	0.00	0.00000	0.00000	307.72000	0.00000
845	21.81	0.00	0.00000	0.00000	307.72000	0.00000
900	21.97	0.00	0.00000	0.00000	307.72000	0.00000
915	22.51	0.00	0.00000	0.00000	307.72000	0.00000
930	23.25	0.00	0.00000	0.00000	307.72000	0.00000
945	24.24	0.00	0.00000	0.00000	307.72000	0.00000
1000	25.20	0.00	0.00000	0.00000	307.72000	0.00000
1015	25.89	0.00	0.00000	0.00000	307.72000	0.00000
1030	26.49	0.00	0.00000	0.00000	307.72000	0.00000
1045	26.66	0.00	0.00000	0.00000	307.72000	0.00000
1100	27.01	0.00	0.00000	0.00000	307.72000	0.00000
1115	27.77	0.00	0.00000	0.00000	307.72000	0.00000
1130	28.61	0.00	0.00000	0.00000	307.72000	0.00000
1145	29.16	0.00	0.00000	0.00000	307.72000	0.00000
1200	28.88	0.28	0.01102	0.04409	350.81379	3.86724
1215	26.77	0.42	0.01654	0.06614	371.47244	6.14246

1230	24.84	0.14	0.00551	0.02205	329.56853	1.81652
1245	23.57	0.00	0.00000	0.00000	307.72000	0.00000
1300	22.93	0.00	0.00000	0.00000	307.72000	0.00000
1315	22.75	0.00	0.00000	0.00000	307.72000	0.00000
1330	22.96	0.00	0.00000	0.00000	307.72000	0.00000
1345	23.51	0.00	0.00000	0.00000	307.72000	0.00000
1400	24.38	0.00	0.00000	0.00000	307.72000	0.00000
1415	25.17	0.00	0.00000	0.00000	307.72000	0.00000
1430	25.90	0.00	0.00000	0.00000	307.72000	0.00000
1445	26.32	0.00	0.00000	0.00000	307.72000	0.00000
1500	27.00	0.00	0.00000	0.00000	307.72000	0.00000
1515	27.95	0.00	0.00000	0.00000	307.72000	0.00000
1530	28.30	0.00	0.00000	0.00000	307.72000	0.00000
1545	27.70	0.00	0.00000	0.00000	307.72000	0.00000
1600	27.51	0.00	0.00000	0.00000	307.72000	0.00000
1615	27.67	0.00	0.00000	0.00000	307.72000	0.00000
1630	27.86	0.00	0.00000	0.00000	307.72000	0.00000
1645	28.08	0.00	0.00000	0.00000	307.72000	0.00000
1700	28.51	0.00	0.00000	0.00000	307.72000	0.00000
1715	28.59	0.00	0.00000	0.00000	307.72000	0.00000
1730	28.16	0.00	0.00000	0.00000	307.72000	0.00000
1745	27.75	0.00	0.00000	0.00000	307.72000	0.00000
1800	26.79	0.00	0.00000	0.00000	307.72000	0.00000
1815	26.01	0.00	0.00000	0.00000	307.72000	0.00000
1830	25.29	1.68	0.06614	0.26457	533.53303	35.28880
1845	23.96	0.00	0.00000	0.00000	307.72000	0.00000
1900	22.60	0.14	0.00551	0.02205	329.56853	1.81652
1915	21.83	0.42	0.01654	0.06614	371.47244	6.14246
1930	21.35	0.56	0.02205	0.08819	391.56066	8.63283
1945	21.05	0.84	0.03307	0.13228	430.08842	14.22340
2000	20.91	1.26	0.04961	0.19843	483.98178	24.00855
2015	20.84	0.56	0.02205	0.08819	391.56066	8.63283
2030	20.83	0.28	0.01102	0.04409	350.81379	3.86724
2045	20.80	0.14	0.00551	0.02205	329.56853	1.81652
2100	20.72	0.14	0.00551	0.02205	329.56853	1.81652
2115	20.71	0.70	0.02756	0.11024	411.09422	11.32937
2130	20.70	0.56	0.02205	0.08819	391.56066	8.63283
2145	20.67	0.00	0.00000	0.00000	307.72000	0.00000
2200	20.71	0.14	0.00551	0.02205	329.56853	1.81652
2215	20.71	0.14	0.00551	0.02205	329.56853	1.81652
2230	20.69	0.00	0.00000	0.00000	307.72000	0.00000
2245	20.64	0.00	0.00000	0.00000	307.72000	0.00000
2300	20.60	0.28	0.01102	0.04409	350.81379	3.86724
2315	20.56	0.28	0.01102	0.04409	350.81379	3.86724
2330	20.54	0.00	0.00000	0.00000	307.72000	0.00000
2345	20.51	0.00	0.00000	0.00000	307.72000	0.00000
0	20.42	0.00	0.00000	0.00000	307.72000	0.00000
15	20.31	0.00	0.00000	0.00000	307.72000	0.00000
30	20.27	0.00	0.00000	0.00000	307.72000	0.00000
45	20.33	0.00	0.00000	0.00000	307.72000	0.00000
100	20.38	0.00	0.00000	0.00000	307.72000	0.00000
115	20.38	0.00	0.00000	0.00000	307.72000	0.00000
130	20.36	0.00	0.00000	0.00000	307.72000	0.00000
145	20.33	0.00	0.00000	0.00000	307.72000	0.00000
200	20.30	0.00	0.00000	0.00000	307.72000	0.00000
215	20.26	0.00	0.00000	0.00000	307.72000	0.00000

230	20.22	0.00	0.00000	0.00000	307.72000	0.00000	
245	20.19	0.00	0.00000	0.00000	307.72000	0.00000	
300	20.19	0.00	0.00000	0.00000	307.72000	0.00000	
315	20.17	0.00	0.00000	0.00000	307.72000	0.00000	
330	20.14	0.00	0.00000	0.00000	307.72000	0.00000	
345	20.12	0.00	0.00000	0.00000	307.72000	0.00000	
400	20.11	0.00	0.00000	0.00000	307.72000	0.00000	
415	20.09	0.00	0.00000	0.00000	307.72000	0.00000	
430	20.07	0.00	0.00000	0.00000	307.72000	0.00000	
445	20.05	0.00	0.00000	0.00000	307.72000	0.00000	
500	20.08	0.00	0.00000	0.00000	307.72000	0.00000	
515	20.12	0.00	0.00000	0.00000	307.72000	0.00000	
530	20.18	0.00	0.00000	0.00000	307.72000	0.00000	
545	20.23	0.00	0.00000	0.00000	307.72000	0.00000	
600	20.28	0.00	0.00000	0.00000	307.72000	0.00000	
615	20.32	0.00	0.00000	0.00000	307.72000	0.00000	
630	20.38	0.00	0.00000	0.00000	307.72000	0.00000	
645	20.44	0.00	0.00000	0.00000	307.72000	0.00000	
700	20.51	0.00	0.00000	0.00000	307.72000	0.00000	
715	20.59	0.00	0.00000	0.00000	307.72000	0.00000	
730	20.67	0.00	0.00000	0.00000	307.72000	0.00000	
745	20.79	0.00	0.00000	0.00000	307.72000	0.00000	
800	20.91	0.00	0.00000	0.00000	307.72000	0.00000	
815	21.04	0.00	0.00000	0.00000	307.72000	0.00000	
830	21.14	0.00	0.00000	0.00000	307.72000	0.00000	
845	21.22	0.00	0.00000	0.00000	307.72000	0.00000	
900	21.27	0.00	0.00000	0.00000	307.72000	0.00000	
915	21.16	16.94	0.66693	2.66772	1072.27360	715.13050	
930	20.70	1.68	0.06614	0.26457	533.53303	35.28880	1.46614
945	20.42	0.42	0.01654	0.06614	371.47244	6.14246	
1000	20.36	0.28	0.01102	0.04409	350.81379	3.86724	
1015	20.47	0.00			E=	1839.23631	
1030	20.82	0.00			Max.I30=	1.46614	
1045	21.15	0.00			EI30=	26.96581	#2
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**
1800	27.12	3.22	0.12677	0.50709	683.42966	86.63951	
1815	25.50	0.84	0.03307	0.13228	430.08842	14.22340	
1830	24.16	0.00	0.00000	0.00000	307.72000	0.00000	
1845	24.33	0.00	0.00000	0.00000	307.72000	0.00000	
1900	24.76	0.00	0.00000	0.00000	307.72000	0.00000	
1915	25.40	0.00	0.00000	0.00000	307.72000	0.00000	
1930	25.86	0.00	0.00000	0.00000	307.72000	0.00000	
1945	25.77	0.00	0.00000	0.00000	307.72000	0.00000	
2000	25.26	0.00	0.00000	0.00000	307.72000	0.00000	
2015	25.29	0.00	0.00000	0.00000	307.72000	0.00000	
2030	24.90	0.00	0.00000	0.00000	307.72000	0.00000	
2045	24.28	0.00	0.00000	0.00000	307.72000	0.00000	
2100	23.58	0.00	0.00000	0.00000	307.72000	0.00000	
2115	22.84	0.00	0.00000	0.00000	307.72000	0.00000	
2130	22.33	0.00	0.00000	0.00000	307.72000	0.00000	
2145	22.20	0.00	0.00000	0.00000	307.72000	0.00000	
2200	22.08	0.00	0.00000	0.00000	307.72000	0.00000	
2215	21.65	0.00	0.00000	0.00000	307.72000	0.00000	
2230	21.19	0.00	0.00000	0.00000	307.72000	0.00000	
2245	20.77	0.00	0.00000	0.00000	307.72000	0.00000	
2300	20.42	0.00	0.00000	0.00000	307.72000	0.00000	

2315	20.20	0.00	0.00000	0.00000	307.72000	0.00000
2330	19.98	0.00	0.00000	0.00000	307.72000	0.00000
2345	19.76	0.00	0.00000	0.00000	307.72000	0.00000
0	19.57	0.00	0.00000	0.00000	307.72000	0.00000
15	19.44	0.00	0.00000	0.00000	307.72000	0.00000
30	19.31	0.00	0.00000	0.00000	307.72000	0.00000
45	19.14	0.00	0.00000	0.00000	307.72000	0.00000
100	19.01	0.00	0.00000	0.00000	307.72000	0.00000
115	18.95	0.00	0.00000	0.00000	307.72000	0.00000
130	18.90	0.00	0.00000	0.00000	307.72000	0.00000
145	18.86	0.00	0.00000	0.00000	307.72000	0.00000
200	18.81	0.00	0.00000	0.00000	307.72000	0.00000
215	18.74	0.00	0.00000	0.00000	307.72000	0.00000
230	18.66	0.00	0.00000	0.00000	307.72000	0.00000
245	18.60	0.00	0.00000	0.00000	307.72000	0.00000
300	18.54	0.00	0.00000	0.00000	307.72000	0.00000
315	18.42	0.00	0.00000	0.00000	307.72000	0.00000
330	18.32	0.00	0.00000	0.00000	307.72000	0.00000
345	18.17	0.00	0.00000	0.00000	307.72000	0.00000
400	18.06	0.00	0.00000	0.00000	307.72000	0.00000
415	18.04	0.00	0.00000	0.00000	307.72000	0.00000
430	18.01	0.00	0.00000	0.00000	307.72000	0.00000
445	17.99	0.00	0.00000	0.00000	307.72000	0.00000
500	17.92	0.00	0.00000	0.00000	307.72000	0.00000
515	17.78	0.00	0.00000	0.00000	307.72000	0.00000
530	17.73	0.00	0.00000	0.00000	307.72000	0.00000
545	17.82	0.00	0.00000	0.00000	307.72000	0.00000
600	18.04	0.00	0.00000	0.00000	307.72000	0.00000
615	18.19	0.00	0.00000	0.00000	307.72000	0.00000
630	18.16	0.00	0.00000	0.00000	307.72000	0.00000
645	18.27	0.00	0.00000	0.00000	307.72000	0.00000
700	18.47	0.00	0.00000	0.00000	307.72000	0.00000
715	18.64	0.00	0.00000	0.00000	307.72000	0.00000
730	18.69	0.00	0.00000	0.00000	307.72000	0.00000
745	18.72	0.00	0.00000	0.00000	307.72000	0.00000
800	18.76	0.00	0.00000	0.00000	307.72000	0.00000
815	18.85	0.00	0.00000	0.00000	307.72000	0.00000
830	19.04	0.00	0.00000	0.00000	307.72000	0.00000
845	19.46	0.00	0.00000	0.00000	307.72000	0.00000
900	19.79	0.00	0.00000	0.00000	307.72000	0.00000
915	20.11	0.00	0.00000	0.00000	307.72000	0.00000
930	20.34	0.00	0.00000	0.00000	307.72000	0.00000
945	20.75	0.00	0.00000	0.00000	307.72000	0.00000
1000	21.42	0.00	0.00000	0.00000	307.72000	0.00000
1015	21.98	0.00	0.00000	0.00000	307.72000	0.00000
1030	22.65	0.00	0.00000	0.00000	307.72000	0.00000
1045	23.51	0.00	0.00000	0.00000	307.72000	0.00000
1100	23.86	0.00	0.00000	0.00000	307.72000	0.00000
1115	24.20	0.00	0.00000	0.00000	307.72000	0.00000
1130	24.59	0.00	0.00000	0.00000	307.72000	0.00000
1145	24.91	0.00	0.00000	0.00000	307.72000	0.00000
1200	25.31	0.00	0.00000	0.00000	307.72000	0.00000
1215	25.98	0.00	0.00000	0.00000	307.72000	0.00000
1230	26.22	0.00	0.00000	0.00000	307.72000	0.00000
1245	27.00	0.00	0.00000	0.00000	307.72000	0.00000
1300	28.83	0.00	0.00000	0.00000	307.72000	0.00000

1315	29.81	0.00	0.00000	0.00000	307.72000	0.00000	
1330	30.12	0.00	0.00000	0.00000	307.72000	0.00000	
1345	30.32	0.00	0.00000	0.00000	307.72000	0.00000	
1400	29.72	0.00	0.00000	0.00000	307.72000	0.00000	
1415	29.56	0.00	0.00000	0.00000	307.72000	0.00000	
1430	30.49	0.00	0.00000	0.00000	307.72000	0.00000	
1445	31.59	0.00	0.00000	0.00000	307.72000	0.00000	
1500	32.38	0.00	0.00000	0.00000	307.72000	0.00000	
1515	32.08	0.00	0.00000	0.00000	307.72000	0.00000	
1530	31.06	0.00	0.00000	0.00000	307.72000	0.00000	
1545	30.61	0.00	0.00000	0.00000	307.72000	0.00000	
1600	30.31	0.00	0.00000	0.00000	307.72000	0.00000	
1615	30.77	0.00	0.00000	0.00000	307.72000	0.00000	
1630	31.65	0.00	0.00000	0.00000	307.72000	0.00000	
1645	32.20	0.00	0.00000	0.00000	307.72000	0.00000	
1700	31.68	0.00	0.00000	0.00000	307.72000	0.00000	
1715	30.17	0.00	0.00000	0.00000	307.72000	0.00000	
1730	28.56	0.00	0.00000	0.00000	307.72000	0.00000	
1745	27.23	0.00	0.00000	0.00000	307.72000	0.00000	
1800	26.35	0.00	0.00000	0.00000	307.72000	0.00000	
1815	25.51	1.12	0.04409	0.17638	466.51792	20.57087	
1830	24.36	11.06	0.43543	1.74173	1012.36951	440.81916	0.95906
1845	23.29	0.98	0.03858	0.15433	448.55816	17.30657	
1900	22.57	0.00			E=	579.55951	
1915	21.82	0.00			Max.I30=	0.95906	
1930	21.31	0.00			EI30=	5.55830	# 3
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**
1815	31.46	2.38	0.09370	0.37480	607.40663	56.91448	
1830	28.34	12.04	0.47402	1.89606	1027.78867	487.18802	1.13543
1845	25.58	0.28	0.01102	0.04409	350.81379	3.86724	
1900	24.32	0.14	0.00551	0.02205	329.56853	1.81652	
1915	23.94	0.00	0.00000	0.00000	307.72000	0.00000	
1930	23.93	0.00	0.00000	0.00000	307.72000	0.00000	
1945	24.13	0.00	0.00000	0.00000	307.72000	0.00000	
2000	24.41	0.00	0.00000	0.00000	307.72000	0.00000	
2015	24.19	0.00	0.00000	0.00000	307.72000	0.00000	
2030	23.67	0.00	0.00000	0.00000	307.72000	0.00000	
2045	23.14	0.00	0.00000	0.00000	307.72000	0.00000	
2100	22.67	0.00	0.00000	0.00000	307.72000	0.00000	
2115	22.27	0.00	0.00000	0.00000	307.72000	0.00000	
2130	22.00	0.00	0.00000	0.00000	307.72000	0.00000	
2145	21.75	0.00	0.00000	0.00000	307.72000	0.00000	
2200	21.62	0.00	0.00000	0.00000	307.72000	0.00000	
2215	21.52	0.00	0.00000	0.00000	307.72000	0.00000	
2230	21.44	0.00	0.00000	0.00000	307.72000	0.00000	
2245	21.36	0.00	0.00000	0.00000	307.72000	0.00000	
2300	21.27	0.00	0.00000	0.00000	307.72000	0.00000	
2315	21.17	0.00	0.00000	0.00000	307.72000	0.00000	
2330	21.09	0.00	0.00000	0.00000	307.72000	0.00000	
2345	21.07	0.00	0.00000	0.00000	307.72000	0.00000	
0	21.06	0.00	0.00000	0.00000	307.72000	0.00000	
15	21.08	0.00	0.00000	0.00000	307.72000	0.00000	
30	21.06	0.00	0.00000	0.00000	307.72000	0.00000	
45	21.09	0.00	0.00000	0.00000	307.72000	0.00000	
100	21.04	0.00	0.00000	0.00000	307.72000	0.00000	
115	20.95	0.00	0.00000	0.00000	307.72000	0.00000	

130	20.95	0.00	0.00000	0.00000	307.72000	0.00000	
145	21.16	0.00	0.00000	0.00000	307.72000	0.00000	
200	21.36	0.00	0.00000	0.00000	307.72000	0.00000	
215	21.33	0.00	0.00000	0.00000	307.72000	0.00000	
230	21.31	0.00	0.00000	0.00000	307.72000	0.00000	
245	21.33	0.00	0.00000	0.00000	307.72000	0.00000	
300	21.28	0.00	0.00000	0.00000	307.72000	0.00000	
315	21.19	0.00	0.00000	0.00000	307.72000	0.00000	
330	21.03	0.00	0.00000	0.00000	307.72000	0.00000	
345	20.86	0.00	0.00000	0.00000	307.72000	0.00000	
400	20.80	0.00	0.00000	0.00000	307.72000	0.00000	
415	20.87	0.00	0.00000	0.00000	307.72000	0.00000	
430	20.93	0.00	0.00000	0.00000	307.72000	0.00000	
445	20.92	0.00	0.00000	0.00000	307.72000	0.00000	
500	20.81	0.28	0.01102	0.04409	350.81379	3.86724	
515	20.55	0.00	0.00000	0.00000	307.72000	0.00000	
530	20.33	0.14	0.00551	0.02205	329.56853	1.81652	
545	20.22	0.00	0.00000	0.00000	307.72000	0.00000	
600	20.18	0.00	0.00000	0.00000	307.72000	0.00000	
615	20.21	0.00	0.00000	0.00000	307.72000	0.00000	
630	20.22	0.00	0.00000	0.00000	307.72000	0.00000	
645	20.24	0.00	0.00000	0.00000	307.72000	0.00000	
700	20.28	0.00	0.00000	0.00000	307.72000	0.00000	
715	20.30	0.00	0.00000	0.00000	307.72000	0.00000	
730	20.32	0.00	0.00000	0.00000	307.72000	0.00000	
745	20.33	0.00	0.00000	0.00000	307.72000	0.00000	
800	20.37	0.00	0.00000	0.00000	307.72000	0.00000	
815	20.40	0.00	0.00000	0.00000	307.72000	0.00000	
830	20.52	0.00	0.00000	0.00000	307.72000	0.00000	
845	20.77	0.00	0.00000	0.00000	307.72000	0.00000	
900	21.11	0.00	0.00000	0.00000	307.72000	0.00000	
915	22.23	0.00	0.00000	0.00000	307.72000	0.00000	
930	23.32	0.00	0.00000	0.00000	307.72000	0.00000	
945	23.33	0.00	0.00000	0.00000	307.72000	0.00000	
1000	23.22	0.00	0.00000	0.00000	307.72000	0.00000	
1015	23.28	0.00	0.00000	0.00000	307.72000	0.00000	
1030	23.65	0.00	0.00000	0.00000	307.72000	0.00000	
1045	24.09	0.00	0.00000	0.00000	307.72000	0.00000	
1100	24.36	0.00	0.00000	0.00000	307.72000	0.00000	
1115	24.41	0.00	0.00000	0.00000	307.72000	0.00000	
1130	24.24	0.14	0.00551	0.02205	329.56853	1.81652	
1145	23.66	0.14	0.00551	0.02205	329.56853	1.81652	
1200	23.24	0.00			E=	559.10305	
1215	23.45	0.00			Max.I30=	1.13543	
1230	24.08	0.00			EI30=	6.34824	# 4A
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**
500	22.34	0.14	0.00551	0.02205	329.56853	1.81652	
515	22.23	1.40	0.05512	0.22047	500.96344	27.61216	
530	21.99	1.82	0.07165	0.28661	549.14650	39.34829	
545	21.69	0.00	0.00000	0.00000	307.72000	0.00000	
600	21.39	0.00	0.00000	0.00000	307.72000	0.00000	
615	21.22	0.00	0.00000	0.00000	307.72000	0.00000	
630	21.14	0.00	0.00000	0.00000	307.72000	0.00000	
645	21.11	0.00	0.00000	0.00000	307.72000	0.00000	
700	21.12	0.70	0.02756	0.11024	411.09422	11.32937	
715	21.17	4.06	0.15984	0.63937	747.69602	119.51362	

730	21.21	8.40	0.33071	1.32283	951.52600	314.67789	
745	21.21	9.94	0.39134	1.56535	990.61910	387.66747	1.44409
800	21.17	2.66	0.10472	0.41890	634.17923	66.41405	
815	21.18	0.14	0.00551	0.02205	329.56853	1.81652	
830	21.25	0.70	0.02756	0.11024	411.09422	11.32937	
845	21.31	0.00	0.00000	0.00000	307.72000	0.00000	
900	21.44	0.00	0.00000	0.00000	307.72000	0.00000	
915	21.64	4.76	0.18740	0.74961	793.59099	148.72020	
930	21.67	2.10	0.08268	0.33071	579.09199	47.87768	
945	21.69	0.14	0.00551	0.02205	329.56853	1.81652	
1000	21.77	0.14	0.00551	0.02205	329.56853	1.81652	
1015	21.93	0.14	0.00551	0.02205	329.56853	1.81652	
1030	22.03	0.14	0.00551	0.02205	329.56853	1.81652	
1045	22.17	0.00	0.00000	0.00000	307.72000	0.00000	
1100	22.32	0.00	0.00000	0.00000	307.72000	0.00000	
1115	22.48	0.00	0.00000	0.00000	307.72000	0.00000	
1130	22.90	0.00	0.00000	0.00000	307.72000	0.00000	
1145	23.66	0.00	0.00000	0.00000	307.72000	0.00000	
1200	24.53	0.00	0.00000	0.00000	307.72000	0.00000	
1215	25.36	0.00	0.00000	0.00000	307.72000	0.00000	
1230	25.82	0.00	0.00000	0.00000	307.72000	0.00000	
1245	26.17	0.00	0.00000	0.00000	307.72000	0.00000	
1300	26.57	0.00	0.00000	0.00000	307.72000	0.00000	
1315	26.60	0.00	0.00000	0.00000	307.72000	0.00000	
1330	26.97	0.00	0.00000	0.00000	307.72000	0.00000	
1345	27.74	0.00	0.00000	0.00000	307.72000	0.00000	
1400	28.36	0.00	0.00000	0.00000	307.72000	0.00000	
1415	28.98	0.00	0.00000	0.00000	307.72000	0.00000	
1430	29.38	0.00	0.00000	0.00000	307.72000	0.00000	
1445	28.80	0.70	0.02756	0.11024	411.09422	11.32937	
1500	27.04	10.50	0.41339	1.65354	1002.10268	414.25504	
1515	24.57	6.44	0.25354	1.01417	880.74767	223.30768	
1530	23.06	1.96	0.07717	0.30866	564.32885	43.54664	
1545	22.33	0.42	0.01654	0.06614	371.47244	6.14246	
1600	22.01	0.14	0.00551	0.02205	329.56853	1.81652	
1615	21.93	1.12	0.04409	0.17638	466.51792	20.57087	
1630	22.15	0.14	0.00551	0.02205	329.56853	1.81652	
1645	22.50	0.00			E=	1908.17430	
1700	22.55	0.00			Max.I30=	1.44409	
1715	23.12	0.00			EI30=	27.55584	# 4B
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**
545	20.59	0.28	0.01102	0.04409	350.81379	3.86724	
600	20.61	0.00	0.00000	0.00000	307.72000	0.00000	
615	20.53	0.00	0.00000	0.00000	307.72000	0.00000	
630	20.47	0.00	0.00000	0.00000	307.72000	0.00000	
645	20.51	0.00	0.00000	0.00000	307.72000	0.00000	
700	20.53	0.00	0.00000	0.00000	307.72000	0.00000	
715	20.56	0.00	0.00000	0.00000	307.72000	0.00000	
730	20.55	0.00	0.00000	0.00000	307.72000	0.00000	
745	20.65	0.00	0.00000	0.00000	307.72000	0.00000	
800	20.83	0.00	0.00000	0.00000	307.72000	0.00000	
815	20.93	0.14	0.00551	0.02205	329.56853	1.81652	
830	20.95	6.30	0.24803	0.99213	874.55024	216.91600	
845	20.95	3.08	0.12126	0.48504	671.62926	81.44166	
900	20.89	5.04	0.19843	0.79370	810.22383	160.76882	
915	20.64	2.10	0.08268	0.33071	579.09199	47.87768	

930	20.18	0.70	0.02756	0.11024	411.09422	11.32937
945	19.95	0.14	0.00551	0.02205	329.56853	1.81652
1000	20.09	0.00	0.00000	0.00000	307.72000	0.00000
1015	20.39	0.00	0.00000	0.00000	307.72000	0.00000
1030	20.73	0.00	0.00000	0.00000	307.72000	0.00000
1045	21.02	0.00	0.00000	0.00000	307.72000	0.00000
1100	21.31	0.00	0.00000	0.00000	307.72000	0.00000
1115	21.65	0.00	0.00000	0.00000	307.72000	0.00000
1130	22.08	0.00	0.00000	0.00000	307.72000	0.00000
1145	22.53	0.00	0.00000	0.00000	307.72000	0.00000
1200	23.09	0.00	0.00000	0.00000	307.72000	0.00000
1215	23.61	0.00	0.00000	0.00000	307.72000	0.00000
1230	23.90	0.00	0.00000	0.00000	307.72000	0.00000
1245	24.19	0.00	0.00000	0.00000	307.72000	0.00000
1300	24.72	0.00	0.00000	0.00000	307.72000	0.00000
1315	25.59	0.00	0.00000	0.00000	307.72000	0.00000
1330	25.53	0.00	0.00000	0.00000	307.72000	0.00000
1345	25.60	0.00	0.00000	0.00000	307.72000	0.00000
1400	25.99	0.00	0.00000	0.00000	307.72000	0.00000
1415	26.55	0.00	0.00000	0.00000	307.72000	0.00000
1430	27.76	0.00	0.00000	0.00000	307.72000	0.00000
1445	28.37	0.00	0.00000	0.00000	307.72000	0.00000
1500	28.68	0.00	0.00000	0.00000	307.72000	0.00000
1515	28.86	0.00	0.00000	0.00000	307.72000	0.00000
1530	28.94	0.00	0.00000	0.00000	307.72000	0.00000
1545	28.70	0.00	0.00000	0.00000	307.72000	0.00000
1600	28.76	0.00	0.00000	0.00000	307.72000	0.00000
1615	28.94	0.00	0.00000	0.00000	307.72000	0.00000
1630	29.28	0.00	0.00000	0.00000	307.72000	0.00000
1645	29.25	0.00	0.00000	0.00000	307.72000	0.00000
1700	29.57	0.00	0.00000	0.00000	307.72000	0.00000
1715	29.73	0.00	0.00000	0.00000	307.72000	0.00000
1730	29.46	0.00	0.00000	0.00000	307.72000	0.00000
1745	28.95	0.00	0.00000	0.00000	307.72000	0.00000
1800	28.27	0.00	0.00000	0.00000	307.72000	0.00000
1815	27.72	0.00	0.00000	0.00000	307.72000	0.00000
1830	27.26	0.00	0.00000	0.00000	307.72000	0.00000
1845	26.78	0.00	0.00000	0.00000	307.72000	0.00000
1900	26.32	0.00	0.00000	0.00000	307.72000	0.00000
1915	25.91	0.00	0.00000	0.00000	307.72000	0.00000
1930	25.57	0.00	0.00000	0.00000	307.72000	0.00000
1945	25.32	0.00	0.00000	0.00000	307.72000	0.00000
2000	25.03	0.00	0.00000	0.00000	307.72000	0.00000
2015	24.73	0.00	0.00000	0.00000	307.72000	0.00000
2030	24.57	0.00	0.00000	0.00000	307.72000	0.00000
2045	24.35	0.00	0.00000	0.00000	307.72000	0.00000
2100	24.00	0.00	0.00000	0.00000	307.72000	0.00000
2115	23.55	0.00	0.00000	0.00000	307.72000	0.00000
2130	23.28	0.00	0.00000	0.00000	307.72000	0.00000
2145	23.22	0.00	0.00000	0.00000	307.72000	0.00000
2200	23.13	0.00	0.00000	0.00000	307.72000	0.00000
2215	22.92	0.00	0.00000	0.00000	307.72000	0.00000
2230	22.77	0.00	0.00000	0.00000	307.72000	0.00000
2245	22.69	0.00	0.00000	0.00000	307.72000	0.00000
2300	22.62	0.00	0.00000	0.00000	307.72000	0.00000
2315	22.66	0.00	0.00000	0.00000	307.72000	0.00000

2330	22.76	0.00	0.00000	0.00000	307.72000	0.00000		
2345	22.85	0.00	0.00000	0.00000	307.72000	0.00000		
0	22.88	0.00	0.00000	0.00000	307.72000	0.00000		
15	22.75	0.00	0.00000	0.00000	307.72000	0.00000		
30	22.53	0.00	0.00000	0.00000	307.72000	0.00000		
45	22.40	0.00	0.00000	0.00000	307.72000	0.00000		
100	22.29	0.00	0.00000	0.00000	307.72000	0.00000		
115	22.22	0.00	0.00000	0.00000	307.72000	0.00000		
130	22.16	0.00	0.00000	0.00000	307.72000	0.00000		
145	22.17	16.80	0.66142	2.64567	1071.51468	708.71837		
200	20.98	5.32	0.20945	0.83780	825.95083	172.99443		1.74173
215	20.06	0.14	0.00551	0.02205	329.56853	1.81652		
230	19.80	0.00	0.00000	0.00000	307.72000	0.00000		
245	19.43	0.00	0.00000	0.00000	307.72000	0.00000		
300	19.19	0.00	0.00000	0.00000	307.72000	0.00000		
315	19.05	0.00	0.00000	0.00000	307.72000	0.00000		
330	18.93	0.00	0.00000	0.00000	307.72000	0.00000		
345	18.85	0.14	0.00551	0.02205	329.56853	1.81652		
400	18.84	0.42	0.01654	0.06614	371.47244	6.14246		
415	18.78	0.14	0.00551	0.02205	329.56853	1.81652		
430	18.76	0.14	0.00551	0.02205	329.56853	1.81652		
445	18.71	0.00			E=	1420.95515		
500	18.61	0.00			Max.I30=	1.74173		
515	18.44	0.00			EI30=	24.74923	# 5	
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**	
1915	28.40	5.32	0.20945	0.83780	825.95083	172.99443		
1930	26.28	17.22	0.67795	2.71181	1073.72914	727.93763		
1945	24.20	33.18	1.30630	5.22520	1097.96163	1434.26641		3.96850
2000	22.40	10.50	0.41339	1.65354	1002.10268	414.25504		
2015	21.56	2.38	0.09370	0.37480	607.40663	56.91448		
2030	21.29	0.98	0.03858	0.15433	448.55816	17.30657		
2045	21.20	0.00			E=	2823.67457		
2100	21.13	0.00			Max.I30=	3.96850		
2115	21.01	0.00			EI30=	112.05764	#6	
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**	
930	22.42	0.14	0.00551	0.02205	329.56853	1.81652		
945	22.42	1.26	0.04961	0.19843	483.98178	24.00855		
1000	22.30	0.14	0.00551	0.02205	329.56853	1.81652		
1015	22.29	0.00	0.00000	0.00000	307.72000	0.00000		
1030	22.42	0.00	0.00000	0.00000	307.72000	0.00000		
1045	22.70	0.14	0.00551	0.02205	329.56853	1.81652		
1100	23.14	0.00	0.00000	0.00000	307.72000	0.00000		
1115	23.52	0.00	0.00000	0.00000	307.72000	0.00000		
1130	23.66	0.42	0.01654	0.06614	371.47244	6.14246		
1145	23.55	0.56	0.02205	0.08819	391.56066	8.63283		
1200	23.30	0.56	0.02205	0.08819	391.56066	8.63283		
1215	23.15	3.08	0.12126	0.48504	671.62926	81.44166		
1230	23.10	1.68	0.06614	0.26457	533.53303	35.28880		
1245	23.02	0.00	0.00000	0.00000	307.72000	0.00000		
1300	23.03	0.00	0.00000	0.00000	307.72000	0.00000		
1315	23.27	0.00	0.00000	0.00000	307.72000	0.00000		
1330	23.46	0.00	0.00000	0.00000	307.72000	0.00000		
1345	23.72	0.00	0.00000	0.00000	307.72000	0.00000		
1400	24.05	0.00	0.00000	0.00000	307.72000	0.00000		
1415	24.33	0.00	0.00000	0.00000	307.72000	0.00000		
1430	24.39	0.00	0.00000	0.00000	307.72000	0.00000		

1445	24.17	0.00	0.00000	0.00000	307.72000	0.00000	
1500	23.78	0.00	0.00000	0.00000	307.72000	0.00000	
1515	23.24	11.48	0.45197	1.80787	1019.34922	460.71374	
1530	22.53	13.86	0.54567	2.18268	1049.51588	572.68858	1.99528
1545	22.05	5.04	0.19843	0.79370	810.22383	160.76882	
1600	21.75	6.44	0.25354	1.01417	880.74767	223.30768	
1615	21.35	0.70	0.02756	0.11024	411.09422	11.32937	
1630	21.18	0.42	0.01654	0.06614	371.47244	6.14246	
1645	21.41	0.00	0.00000	0.00000	307.72000	0.00000	
1700	22.13	0.00	0.00000	0.00000	307.72000	0.00000	
1715	22.61	0.00	0.00000	0.00000	307.72000	0.00000	
1730	22.66	0.00	0.00000	0.00000	307.72000	0.00000	
1745	22.55	0.00	0.00000	0.00000	307.72000	0.00000	
1800	22.39	0.00	0.00000	0.00000	307.72000	0.00000	
1815	22.21	0.14	0.00551	0.02205	329.56853	1.81652	
1830	22.01	0.42	0.01654	0.06614	371.47244	6.14246	
1845	21.89	1.12	0.04409	0.17638	466.51792	20.57087	
1900	21.84	0.42	0.01654	0.06614	371.47244	6.14246	
1915	21.79	0.42	0.01654	0.06614	371.47244	6.14246	
1930	21.72	0.56	0.02205	0.08819	391.56066	8.63283	
1945	21.67	0.84	0.03307	0.13228	430.08842	14.22340	
2000	21.64	0.98	0.03858	0.15433	448.55816	17.30657	
2015	21.62	0.14	0.00551	0.02205	329.56853	1.81652	
2030	21.50	0.00	0.00000	0.00000	307.72000	0.00000	
2045	21.39	0.00	0.00000	0.00000	307.72000	0.00000	
2100	21.32	0.14	0.00551	0.02205	329.56853	1.81652	
2115	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
2130	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
2145	21.29	0.14	0.00551	0.02205	329.56853	1.81652	
2200	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
2215	21.25	0.00	0.00000	0.00000	307.72000	0.00000	
2230	21.24	0.00	0.00000	0.00000	307.72000	0.00000	
2245	21.28	0.14	0.00551	0.02205	329.56853	1.81652	
2300	21.31	0.28	0.01102	0.04409	350.81379	3.86724	
2315	21.37	0.14	0.00551	0.02205	329.56853	1.81652	
2330	21.40	0.00	0.00000	0.00000	307.72000	0.00000	
2345	21.42	0.00	0.00000	0.00000	307.72000	0.00000	
0	21.39	0.14	0.00551	0.02205	329.56853	1.81652	
15	21.33	0.00	0.00000	0.00000	307.72000	0.00000	
30	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
45	21.25	0.00	0.00000	0.00000	307.72000	0.00000	
100	21.24	0.00	0.00000	0.00000	307.72000	0.00000	
115	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
130	21.33	0.14	0.00551	0.02205	329.56853	1.81652	
145	21.34	0.00	0.00000	0.00000	307.72000	0.00000	
200	21.33	0.00	0.00000	0.00000	307.72000	0.00000	
215	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
230	21.29	0.00	0.00000	0.00000	307.72000	0.00000	
245	21.28	0.00	0.00000	0.00000	307.72000	0.00000	
300	21.22	0.00	0.00000	0.00000	307.72000	0.00000	
315	21.21	0.00	0.00000	0.00000	307.72000	0.00000	
330	21.20	0.00	0.00000	0.00000	307.72000	0.00000	
345	21.22	0.14	0.00551	0.02205	329.56853	1.81652	
400	21.22	0.00	0.00000	0.00000	307.72000	0.00000	
415	21.19	0.00	0.00000	0.00000	307.72000	0.00000	
430	21.12	0.00	0.00000	0.00000	307.72000	0.00000	

445	21.05	0.00	0.00000	0.00000	307.72000	0.00000	
500	21.07	0.14	0.00551	0.02205	329.56853	1.81652	
515	21.11	0.00	0.00000	0.00000	307.72000	0.00000	
530	21.16	0.56	0.02205	0.08819	391.56066	8.63283	
545	21.18	0.84	0.03307	0.13228	430.08842	14.22340	
600	21.16	0.00	0.00000	0.00000	307.72000	0.00000	
615	21.14	0.42	0.01654	0.06614	371.47244	6.14246	
630	21.12	0.56	0.02205	0.08819	391.56066	8.63283	
645	21.13	0.00	0.00000	0.00000	307.72000	0.00000	
700	21.14	0.28	0.01102	0.04409	350.81379	3.86724	
715	21.13	1.40	0.05512	0.22047	500.96344	27.61216	
730	21.13	2.10	0.08268	0.33071	579.09199	47.87768	
745	21.11	1.96	0.07717	0.30866	564.32885	43.54664	
800	21.12	1.96	0.07717	0.30866	564.32885	43.54664	
815	21.11	0.00	0.00000	0.00000	307.72000	0.00000	
830	21.10	0.14	0.00551	0.02205	329.56853	1.81652	
845	21.12	0.00			E=	1911.63921	
900	21.17	0.00			Max.I30=	1.99528	
915	21.25	0.00			EI30=	38.14247	#7

Hr/Min	Ptemp	mm	in.	iph	u.en.	T.en.	max 30
45	20.17	0.14	0.00551	0.02205	329.56853	1.81652	
100	19.63	0.00	0.00000	0.00000	307.72000	0.00000	
115	19.24	0.00	0.00000	0.00000	307.72000	0.00000	
130	18.93	0.00	0.00000	0.00000	307.72000	0.00000	
145	18.77	0.00	0.00000	0.00000	307.72000	0.00000	
200	18.73	0.14	0.00551	0.02205	329.56853	1.81652	
215	18.65	0.14	0.00551	0.02205	329.56853	1.81652	
230	18.54	0.14	0.00551	0.02205	329.56853	1.81652	
245	18.43	0.28	0.01102	0.04409	350.81379	3.86724	
300	18.38	0.28	0.01102	0.04409	350.81379	3.86724	
315	18.32	0.42	0.01654	0.06614	371.47244	6.14246	
330	18.28	0.14	0.00551	0.02205	329.56853	1.81652	
345	18.27	0.14	0.00551	0.02205	329.56853	1.81652	
400	18.27	0.42	0.01654	0.06614	371.47244	6.14246	
415	18.29	0.28	0.01102	0.04409	350.81379	3.86724	
430	18.30	0.00	0.00000	0.00000	307.72000	0.00000	
445	18.35	1.54	0.06063	0.24252	517.47621	31.37454	
500	18.42	0.56	0.02205	0.08819	391.56066	8.63283	
515	18.42	0.42	0.01654	0.06614	371.47244	6.14246	
530	18.41	1.96	0.07717	0.30866	564.32885	43.54664	
545	18.38	0.42	0.01654	0.06614	371.47244	6.14246	
600	18.36	0.42	0.01654	0.06614	371.47244	6.14246	
615	18.36	0.28	0.01102	0.04409	350.81379	3.86724	
630	18.37	0.56	0.02205	0.08819	391.56066	8.63283	
645	18.36	0.28	0.01102	0.04409	350.81379	3.86724	
700	18.36	0.28	0.01102	0.04409	350.81379	3.86724	
715	18.37	0.70	0.02756	0.11024	411.09422	11.32937	
730	18.39	0.14	0.00551	0.02205	329.56853	1.81652	
745	18.41	0.42	0.01654	0.06614	371.47244	6.14246	
800	18.43	0.42	0.01654	0.06614	371.47244	6.14246	
815	18.47	0.42	0.01654	0.06614	371.47244	6.14246	
830	18.52	1.68	0.06614	0.26457	533.53303	35.28880	
845	18.58	0.70	0.02756	0.11024	411.09422	11.32937	
900	18.65	3.22	0.12677	0.50709	683.42966	86.63951	
915	18.72	0.98	0.03858	0.15433	448.55816	17.30657	
930	18.78	1.12	0.04409	0.17638	466.51792	20.57087	

945	18.83	0.84	0.03307	0.13228	430.08842	14.22340		
1000	18.87	0.70	0.02756	0.11024	411.09422	11.32937		
1015	18.95	0.28	0.01102	0.04409	350.81379	3.86724		
1030	19.14	0.28	0.01102	0.04409	350.81379	3.86724		
1045	19.30	0.42	0.01654	0.06614	371.47244	6.14246		
1100	19.40	1.12	0.04409	0.17638	466.51792	20.57087		
1115	19.43	1.40	0.05512	0.22047	500.96344	27.61216		
1130	19.41	0.84	0.03307	0.13228	430.08842	14.22340		
1145	19.45	0.98	0.03858	0.15433	448.55816	17.30657		
1200	19.50	0.84	0.03307	0.13228	430.08842	14.22340		
1215	19.55	0.98	0.03858	0.15433	448.55816	17.30657		
1230	19.57	0.70	0.02756	0.11024	411.09422	11.32937		
1245	19.57	1.96	0.07717	0.30866	564.32885	43.54664		
1300	19.57	1.82	0.07165	0.28661	549.14650	39.34829		
1315	19.61	14.56	0.57323	2.29291	1055.98057	605.31800		
1330	19.44	8.12	0.31969	1.27874	943.03184	301.47317		1.78583
1345	19.23	11.76	0.46299	1.85197	1023.68707	473.95905		
1400	19.04	4.20	0.16535	0.66142	757.39610	125.23872		
1415	18.82	2.38	0.09370	0.37480	607.40663	56.91448		
1430	18.68	1.54	0.06063	0.24252	517.47621	31.37454		
1445	18.65	0.84	0.03307	0.13228	430.08842	14.22340		
1500	18.65	1.68	0.06614	0.26457	533.53303	35.28880		
1515	18.67	2.38	0.09370	0.37480	607.40663	56.91448		
1530	18.66	2.66	0.10472	0.41890	634.17923	66.41405		
1545	18.58	0.84	0.03307	0.13228	430.08842	14.22340		
1600	18.47	0.70	0.02756	0.11024	411.09422	11.32937		
1615	18.49	0.28	0.01102	0.04409	350.81379	3.86724		
1630	18.55	0.14	0.00551	0.02205	329.56853	1.81652		
1645	18.57	0.00	0.00000	0.00000	307.72000	0.00000		
1700	18.71	0.00	0.00000	0.00000	307.72000	0.00000		
1715	18.86	0.00	0.00000	0.00000	307.72000	0.00000		
1730	18.85	0.28	0.01102	0.04409	350.81379	3.86724		
1745	18.72	0.56	0.02205	0.08819	391.56066	8.63283		
1800	18.65	0.00			E=	2415.46230		
1815	18.62	0.00			Max.I30=	1.78583		
1830	18.60	0.00			EI30=	43.13597	#8	
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**	
645	18.64	1.54	0.06063	0.24252	517.47621	31.37454		
700	18.21	0.84	0.03307	0.13228	430.08842	14.22340		
715	17.84	0.00	0.00000	0.00000	307.72000	0.00000		
730	17.65	0.00	0.00000	0.00000	307.72000	0.00000		
745	17.58	0.00	0.00000	0.00000	307.72000	0.00000		
800	17.58	0.00	0.00000	0.00000	307.72000	0.00000		
815	17.60	0.00	0.00000	0.00000	307.72000	0.00000		
830	17.74	0.14	0.00551	0.02205	329.56853	1.81652		
845	17.97	1.40	0.05512	0.22047	500.96344	27.61216		
900	18.08	4.20	0.16535	0.66142	757.39610	125.23872		
915	18.00	0.00	0.00000	0.00000	307.72000	0.00000		
930	17.90	0.00	0.00000	0.00000	307.72000	0.00000		
945	17.85	0.00	0.00000	0.00000	307.72000	0.00000		
1000	18.04	0.00	0.00000	0.00000	307.72000	0.00000		
1015	18.71	0.00	0.00000	0.00000	307.72000	0.00000		
1030	19.39	0.00	0.00000	0.00000	307.72000	0.00000		
1045	20.33	0.00	0.00000	0.00000	307.72000	0.00000		
1100	21.37	0.00	0.00000	0.00000	307.72000	0.00000		
1115	21.99	0.00	0.00000	0.00000	307.72000	0.00000		

1130	22.21	0.00	0.00000	0.00000	307.72000	0.00000		
1145	22.81	0.00	0.00000	0.00000	307.72000	0.00000		
1200	23.58	0.00	0.00000	0.00000	307.72000	0.00000		
1215	23.84	0.00	0.00000	0.00000	307.72000	0.00000		
1230	23.82	0.00	0.00000	0.00000	307.72000	0.00000		
1245	23.61	0.00	0.00000	0.00000	307.72000	0.00000		
1300	23.75	0.00	0.00000	0.00000	307.72000	0.00000		
1315	24.12	0.00	0.00000	0.00000	307.72000	0.00000		
1330	24.65	0.00	0.00000	0.00000	307.72000	0.00000		
1345	25.31	0.00	0.00000	0.00000	307.72000	0.00000		
1400	25.20	0.14	0.00551	0.02205	329.56853	1.81652		
1415	23.95	8.96	0.35276	1.41102	967.15172	341.16848		
1430	21.40	9.38	0.36929	1.47717	977.77457	361.08368		1.44409
1445	19.55	1.12	0.04409	0.17638	466.51792	20.57087		
1500	18.73	0.28	0.01102	0.04409	350.81379	3.86724		
1515	18.38	0.42	0.01654	0.06614	371.47244	6.14246		
1530	18.18	0.28	0.01102	0.04409	350.81379	3.86724		
1545	17.98	0.14	0.00551	0.02205	329.56853	1.81652		
1600	17.76	0.00			E=	940.59834		
1615	17.69	0.00			Max.i30=	1.44409		
1630	17.79	0.00			EI30=	13.58313	#9	
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**	
1000	18.40	0.14	0.00551	0.02205	329.56853	1.81652		
1015	18.23	0.00	0.00000	0.00000	307.72000	0.00000		
1030	18.51	0.00	0.00000	0.00000	307.72000	0.00000		
1045	18.85	0.00	0.00000	0.00000	307.72000	0.00000		
1100	19.35	0.00	0.00000	0.00000	307.72000	0.00000		
1115	20.00	0.00	0.00000	0.00000	307.72000	0.00000		
1130	20.33	0.00	0.00000	0.00000	307.72000	0.00000		
1145	20.35	0.00	0.00000	0.00000	307.72000	0.00000		
1200	20.42	0.00	0.00000	0.00000	307.72000	0.00000		
1215	20.63	0.00	0.00000	0.00000	307.72000	0.00000		
1230	20.53	0.00	0.00000	0.00000	307.72000	0.00000		
1245	20.01	0.42	0.01654	0.06614	371.47244	6.14246		
1300	19.54	0.00	0.00000	0.00000	307.72000	0.00000		
1315	19.17	0.00	0.00000	0.00000	307.72000	0.00000		
1330	18.92	0.28	0.01102	0.04409	350.81379	3.86724		
1345	18.78	0.70	0.02756	0.11024	411.09422	11.32937		
1400	18.71	1.12	0.04409	0.17638	466.51792	20.57087		
1415	18.66	4.20	0.16535	0.66142	757.39610	125.23872		
1430	18.55	0.70	0.02756	0.11024	411.09422	11.32937		
1445	18.45	0.56	0.02205	0.08819	391.56066	8.63283		
1500	18.37	3.50	0.13780	0.55118	706.06198	97.29201		
1515	18.31	3.36	0.13228	0.52913	694.90424	91.92434		
1530	18.26	9.94	0.39134	1.56535	990.61910	387.66747		1.04724
1545	18.29	0.14	0.00551	0.02205	329.56853	1.81652		
1600	18.25	0.00			E=	767.62772		
1615	18.29	0.00			Max.i30=	1.04724		
1630	18.39	0.00			EI30=	8.03894	#10	
Hr/Min	**Ptemp**	**mm**	**in.**	**iph**	**u.en.**	**T.en.**	**max 30**	
945	14.81	1.68	0.06614	0.26457	533.53303	35.28880		
1000	14.63	0.14	0.00551	0.02205	329.56853	1.81652		
1015	14.46	0.14	0.00551	0.02205	329.56853	1.81652		
1030	14.46	0.00	0.00000	0.00000	307.72000	0.00000		
1045	14.51	1.12	0.04409	0.17638	466.51792	20.57087		
1100	14.49	0.00	0.00000	0.00000	307.72000	0.00000		

1115	14.54	1.54	0.06063	0.24252	517.47621	31.37454
1130	14.55	1.82	0.07165	0.28661	549.14650	39.34829
1145	14.57	0.14	0.00551	0.02205	329.56853	1.81652
1200	14.81	0.00	0.00000	0.00000	307.72000	0.00000
1215	15.10	0.00	0.00000	0.00000	307.72000	0.00000
1230	15.32	0.00	0.00000	0.00000	307.72000	0.00000
1245	15.43	0.00	0.00000	0.00000	307.72000	0.00000
1300	15.47	0.00	0.00000	0.00000	307.72000	0.00000
1315	15.58	0.00	0.00000	0.00000	307.72000	0.00000
1330	15.74	0.00	0.00000	0.00000	307.72000	0.00000
1345	15.96	0.00	0.00000	0.00000	307.72000	0.00000
1400	16.19	0.00	0.00000	0.00000	307.72000	0.00000
1415	16.45	0.00	0.00000	0.00000	307.72000	0.00000
1430	16.58	0.00	0.00000	0.00000	307.72000	0.00000
1445	16.65	0.00	0.00000	0.00000	307.72000	0.00000
1500	16.81	0.00	0.00000	0.00000	307.72000	0.00000
1515	16.81	0.00	0.00000	0.00000	307.72000	0.00000
1530	16.77	0.00	0.00000	0.00000	307.72000	0.00000
1545	16.79	0.00	0.00000	0.00000	307.72000	0.00000
1600	16.83	0.00	0.00000	0.00000	307.72000	0.00000
1615	16.88	0.00	0.00000	0.00000	307.72000	0.00000
1630	17.01	0.00	0.00000	0.00000	307.72000	0.00000
1645	17.06	0.00	0.00000	0.00000	307.72000	0.00000
1700	17.11	0.00	0.00000	0.00000	307.72000	0.00000
1715	17.14	0.00	0.00000	0.00000	307.72000	0.00000
1730	17.17	0.00	0.00000	0.00000	307.72000	0.00000
1745	17.19	0.00	0.00000	0.00000	307.72000	0.00000
1800	17.15	0.00	0.00000	0.00000	307.72000	0.00000
1815	17.06	0.00	0.00000	0.00000	307.72000	0.00000
1830	16.95	0.00	0.00000	0.00000	307.72000	0.00000
1845	16.90	0.00	0.00000	0.00000	307.72000	0.00000
1900	16.82	0.00	0.00000	0.00000	307.72000	0.00000
1915	16.77	0.00	0.00000	0.00000	307.72000	0.00000
1930	16.64	0.00	0.00000	0.00000	307.72000	0.00000
1945	16.44	0.00	0.00000	0.00000	307.72000	0.00000
2000	16.25	0.00	0.00000	0.00000	307.72000	0.00000
2015	16.08	0.00	0.00000	0.00000	307.72000	0.00000
2030	15.94	0.00	0.00000	0.00000	307.72000	0.00000
2045	15.79	0.00	0.00000	0.00000	307.72000	0.00000
2100	15.65	0.00	0.00000	0.00000	307.72000	0.00000
2115	15.47	0.00	0.00000	0.00000	307.72000	0.00000
2130	15.23	0.00	0.00000	0.00000	307.72000	0.00000
2145	15.12	0.00	0.00000	0.00000	307.72000	0.00000
2200	15.06	0.00	0.00000	0.00000	307.72000	0.00000
2215	15.04	0.00	0.00000	0.00000	307.72000	0.00000
2230	14.89	0.00	0.00000	0.00000	307.72000	0.00000
2245	14.76	0.00	0.00000	0.00000	307.72000	0.00000
2300	14.76	0.00	0.00000	0.00000	307.72000	0.00000
2315	14.78	0.00	0.00000	0.00000	307.72000	0.00000
2330	14.79	0.00	0.00000	0.00000	307.72000	0.00000
2345	14.79	0.00	0.00000	0.00000	307.72000	0.00000
0	14.77	0.00	0.00000	0.00000	307.72000	0.00000
15	14.66	0.00	0.00000	0.00000	307.72000	0.00000
30	14.50	0.00	0.00000	0.00000	307.72000	0.00000
45	14.32	0.00	0.00000	0.00000	307.72000	0.00000
100	14.12	0.00	0.00000	0.00000	307.72000	0.00000

115	13.91	0.00	0.00000	0.00000	307.72000	0.00000		
130	13.67	0.14	0.00551	0.02205	329.56853	1.81652		
145	13.45	0.14	0.00551	0.02205	329.56853	1.81652		
200	13.25	0.00	0.00000	0.00000	307.72000	0.00000		
215	13.04	0.14	0.00551	0.02205	329.56853	1.81652		
230	12.83	0.42	0.01654	0.06614	371.47244	6.14246		
245	12.66	0.28	0.01102	0.04409	350.81379	3.86724		
300	12.52	0.14	0.00551	0.02205	329.56853	1.81652		
315	12.37	0.28	0.01102	0.04409	350.81379	3.86724		
330	12.20	1.12	0.04409	0.17638	466.51792	20.57087		
345	12.00	0.42	0.01654	0.06614	371.47244	6.14246		
400	11.81	0.56	0.02205	0.08819	391.56066	8.63283		
415	11.63	0.14	0.00551	0.02205	329.56853	1.81652		
430	11.49	0.00	0.00000	0.00000	307.72000	0.00000		
445	11.30	0.00	0.00000	0.00000	307.72000	0.00000		
500	11.15	0.00	0.00000	0.00000	307.72000	0.00000		
515	11.00	0.00	0.00000	0.00000	307.72000	0.00000		
530	10.86	0.14	0.00551	0.02205	329.56853	1.81652		
545	10.60	0.14	0.00551	0.02205	329.56853	1.81652		
600	10.28	0.00	0.00000	0.00000	307.72000	0.00000		
615	10.07	1.26	0.04961	0.19843	483.98178	24.00855		
630	9.82	0.42	0.01654	0.06614	371.47244	6.14246		
645	9.61	0.28	0.01102	0.04409	350.81379	3.86724		
700	9.45	0.98	0.03858	0.15433	448.55816	17.30657		
715	9.33	1.40	0.05512	0.22047	500.96344	27.61216		
730	9.25	1.82	0.07165	0.28661	549.14650	39.34829		0.25354
745	9.17	0.98	0.03858	0.15433	448.55816	17.30657		
800	9.10	1.96	0.07717	0.30866	564.32885	43.54664		
815	9.06	0.28	0.01102	0.04409	350.81379	3.86724		
830	8.98	0.84	0.03307	0.13228	430.08842	14.22340		
845	8.91	0.00	0.00000	0.00000	307.72000	0.00000		
900	8.90	0.28	0.01102	0.04409	350.81379	3.86724		
915	8.87	0.70	0.02756	0.11024	411.09422	11.32937		
930	8.89	0.84	0.03307	0.13228	430.08842	14.22340		
945	8.90	0.42	0.01654	0.06614	371.47244	6.14246		
1000	8.83	0.00	0.00000	0.00000	307.72000	0.00000		
1015	8.74	0.28	0.01102	0.04409	350.81379	3.86724		
1030	8.72	0.00	0.00000	0.00000	307.72000	0.00000		
1045	8.75	0.14	0.00551	0.02205	329.56853	1.81652		
1100	8.83	0.00	0.00000	0.00000	307.72000	0.00000		
1115	8.87	0.14	0.00551	0.02205	329.56853	1.81652		
1130	8.90	0.00			E=	434.26264		
1145	9.09	0.00			Max.i30=	0.25354		
1200	9.62	0.00			EI30=	1.10104	#11	

Appendix V

SAS Output

The SAS System

1

The ANOVA Procedure

Runoff 1

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

2

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	96937401.6	32312467.2	0.62	0.6252
Error	7	366044985.9	52292140.8		
Corrected Total	10	462982387.5			

R-Square	Coeff Var	Root MSE	sed Mean
0.209376	154.9636	7231.331	4666.470

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	96937401.56	32312467.19	0.62	0.6252

The SAS System

3

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	52292141
Critical Value of t	0.71114
Least Significant Difference	4453.5
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	9119	3	Bare
B	4594	3	Straw
B			
B	2974	2	50/50
B			
B	1415	3	CBS

The SAS System

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The ANOVA Procedure
Runoff 2
Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	376140632.0	125380210.7	1.51	0.2945
Error	7	582998188.4	83285455.5		
Corrected Total	10	959138820.3			

R-Square	Coeff Var	Root MSE	sed Mean
0.392165	62.83367	9126.087	14524.20

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	376140632.0	125380210.7	1.51	0.2945

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	83285455
Critical Value of t	0.71114
Least Significant Difference	5620.5
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	23668	3	Bare
B	13032	3	Straw
B			
B	11262	3	CBS
B			
B	7940	2	50/50

The SAS System

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The ANOVA Procedure
Runoff 3
Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	94816143.5	31605381.2	2.30	0.1641
Error	7	96184362.7	13740623.2		
Corrected Total	10	191000506.3			

R-Square	Coeff Var	Root MSE	sed Mean
0.496418	73.56920	3706.835	5038.569

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	94816143.54	31605381.18	2.30	0.1641

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	13740623
Critical Value of t	0.71114
Least Significant Difference	2282.9
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	9576	3	Bare
	B	4695	3	Straw
	B			
C	B	2892	3	CBS
C				
C		1968	2	50/50

The SAS System

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The ANOVA Procedure
Runoff 4
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	82405051.5	27468350.5	0.65	0.6090
Error	7	296969049.8	42424150.0		
Corrected Total	10	379374101.3			

R-Square	Coeff Var	Root MSE	sed Mean
0.217213	30.96234	6513.382	21036.46

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	82405051.51	27468350.50	0.65	0.6090

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	42424150
Critical Value of t	0.71114
Least Significant Difference	4011.4
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	23999	3	Control
	A			
	A	22310	3	Straw
	A			
B	A	20084	3	CBS
B				
B		16112	2	50/50

The SAS System

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The ANOVA Procedure

Runoff 5

Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11

Number of Observations Used 11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	69729809.1	23243269.7	0.33	0.8046
Error	7	493875465.8	70553638.0		
Corrected Total	10	563605274.9			

R-Square	Coeff Var	Root MSE	sed Mean
0.123721	34.23871	8399.621	24532.53

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	69729809.07	23243269.69	0.33	0.8046

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	70553638
Critical Value of t	0.71114
Least Significant Difference	5173
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	27232	3	Straw
	A			
	A	26203	3	CBS
	A			
B	A	22736	3	Control
B				
B		20672	2	50/50

The SAS System

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The ANOVA Procedure

Runoff 6

Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2520368484	840122828	4.28	0.0518
Error	7	1375556776	196508111		
Corrected Total	10	3895925260			

R-Square	Coeff Var	Root MSE	sed Mean
0.646924	70.60598	14018.14	19854.03

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	2520368484	840122828	4.28	0.0518

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	1.9651E8
Critical Value of t	0.71114
Least Significant Difference	8633.3
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	44125	3	Control
B	13414	3	Straw
B			
B	11900	3	CBS
B			
B	5039	2	50/50

The SAS System
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The ANOVA Procedure
Runoff 7
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System
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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	691423571	230474524	4.19	0.0542
Error	7	385289575	55041368		
Corrected Total	10	1076713146			

R-Square	Coeff Var	Root MSE	sed Mean
0.642161	49.43158	7418.987	15008.60

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	691423571.0	230474523.7	4.19	0.0542

The SAS System
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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	55041368
Critical Value of t	0.71114
Least Significant Difference	4569.1
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	27312	3	Control
B	14067	3	Straw
C	9029	2	50/50
C			
C	7634	3	CBS

The SAS System

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The ANOVA Procedure
Runoff 8
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11
Number of Observations Used 11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	3518841491	1172947164	2.87	0.1130
Error	7	2857194079	408170583		
Corrected Total	10	6376035570			

R-Square	Coeff Var	Root MSE	sed Mean
0.551885	100.7752	20203.23	20047.81

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	3518841491	1172947164	2.87	0.1130

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	4.0817E8
Critical Value of t	0.71114
Least Significant Difference	12443
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	48444	3	Control
	B	14854	3	Straw
	B			
C	B	8708	3	CBS
C				
C		2255	2	50/50

The SAS System
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The ANOVA Procedure
Runoff 9
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11
Number of Observations Used 11

The SAS System
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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	137132105.0	45710701.7	4.51	0.0462
Error	7	70998282.1	10142611.7		
Corrected Total	10	208130387.1			

R-Square	Coeff Var	Root MSE	sed Mean
0.658876	61.24487	3184.747	5200.022

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	137132105.0	45710701.7	4.51	0.0462

The SAS System
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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	10142612
Critical Value of t	0.71114
Least Significant Difference	1961.4
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	10766	3	Control
B	3918	3	Straw
B			
B	3540	3	CBS
C	1264	2	50/50

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                                 The SAS System
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                              The ANOVA Procedure
                                   Runoff 10
                            Class Level Information

                     Class         Levels    Values

                     trt                4    50/50 CBS Control Straw


                         Number of Observations Read          11
                         Number of Observations Used          11

                                 The SAS System
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                              The ANOVA Procedure

Dependent Variable: sed

                                        Sum of
        Source                      DF         Squares     Mean Square    F Value    Pr > F

        Model                        3     174451828.4      58150609.5      37.15    0.0001

        Error                        7      10957010.0       1565287.1

        Corrected Total             10     185408838.4


                     R-Square     Coeff Var      Root MSE      sed Mean

                     0.940904      20.28242      1251.114      6168.466


        Source                      DF        Anova SS     Mean Square    F Value    Pr > F

        trt                          3     174451828.4      58150609.5      37.15    0.0001
                                 The SAS System
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                              The ANOVA Procedure

                             t Tests (LSD) for sed

 NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error
rate.


                         Alpha                              0.5
                         Error Degrees of Freedom             7
                         Error Mean Square              1565287
                         Critical Value of t            0.71114
                         Least Significant Difference   770.52
                         Harmonic Mean of Cell Sizes  2.666667

                            NOTE: Cell sizes are not equal.

                 Means with the same letter are not significantly different.

                    t Grouping          Mean      N    trt

                             A         12460      3    Control

                             B          5334      3    Straw

                             C          2924      2    50/50
                             C
                             C          2874      3    CBS
```

The SAS System

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The ANOVA Procedure
Runoff 11
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11
Number of Observations Used 11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	77387.5482	25795.8494	0.42	0.7455
Error	7	431604.3344	61657.7621		
Corrected Total	10	508991.8826			

R-Square	Coeff Var	Root MSE	sed Mean
0.152041	34.63454	248.3098	716.9427

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	77387.54817	25795.84939	0.42	0.7455

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	61657.76
Critical Value of t	0.71114
Least Significant Difference	152.93
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	850.3	3	Control
B	695.5	3	Straw
B			
B	655.8	2	50/50
B			
B	645.8	3	CBS

The SAS System

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The ANOVA Procedure
Runoff Total
Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	41775370374	13925123458	4.34	0.0501
Error	7	22443085974	3206155139		
Corrected Total	10	64218456348			

R-Square	Coeff Var	Root MSE	sed Mean
0.650520	41.44965	56622.92	136606.5

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	41775370374	13925123458	4.34	0.0501

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	3.2062E9
Critical Value of t	0.71114
Least Significant Difference	34872
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	233055	3	Bare
	B	123636	3	Straw
	B			
C	B	96977	3	CBS
C				
C		70833	2	50/50

The SAS System

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The ANOVA Procedure
Sediment 1
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	251914489.1	83971496.4	9.24	0.0079
Error	7	63600469.6	9085781.4		
Corrected Total	10	315514958.7			

R-Square	Coeff Var	Root MSE	sed Mean
0.798423	89.75943	3014.263	3358.157

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	251914489.1	83971496.4	9.24	0.0079

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	9085781
Critical Value of t	0.71114
Least Significant Difference	1856.4
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	11171	3	Control
B	563	3	Straw
B			
B	422	3	CBS
B			
B	236	2	50/50

The SAS System

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The ANOVA Procedure

Sediment 2

Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1653345686	551115229	16.40	0.0015
Error	7	235173278	33596183		
Corrected Total	10	1888518964			

R-Square	Coeff Var	Root MSE	sed Mean
0.875472	66.13948	5796.221	8763.634

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	1653345686	551115229	16.40	0.0015

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	33596183
Critical Value of t	0.71114
Least Significant Difference	3569.7
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	28779	3	Control
B	1641	3	CBS
B			
B	1186	2	50/50
B			
B	922	3	Straw

The SAS System

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The ANOVA Procedure
Sediment 3
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	550681290.2	183560430.1	7.20	0.0152
Error	7	178548068.9	25506867.0		
Corrected Total	10	729229359.1			

R-Square	Coeff Var	Root MSE	sed Mean
0.755155	105.6816	5050.432	4778.912

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	550681290.2	183560430.1	7.20	0.0152

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	25506867
Critical Value of t	0.71114
Least Significant Difference	3110.4
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	16329	3	Control
B	718	3	CBS
B			
B	293	2	50/50
B			
B	280	3	Straw

The SAS System

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The ANOVA Procedure
Sediment 4
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2856062967	952020989	304.43	<.0001
Error	7	21890816	3127259		
Corrected Total	10	2877953783			

R-Square	Coeff Var	Root MSE	sed Mean
0.992394	15.65172	1768.406	11298.48

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	2856062967	952020989	304.43	<.0001

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	3127259
Critical Value of t	0.71114
Least Significant Difference	1089.1
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	37611	3	Control
B	1574	2	50/50
B			
B	1444	3	CBS
B			
B	1323	3	Straw

The SAS System

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The ANOVA Procedure

Sediment 5

Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11

Number of Observations Used 11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	3780882920	1260294307	251.56	<.0001
Error	7	35069608	5009944		
Corrected Total	10	3815952528			

R-Square	Coeff Var	Root MSE	sed Mean
0.990810	15.19911	2238.290	14726.46

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	3780882920	1260294307	251.56	<.0001

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	5009944
Critical Value of t	0.71114
Least Significant Difference	1378.5
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	45000	3	Control
B	3649	3	CBS
B			
B	3266	2	50/50
B			
B	3171	3	Straw

The SAS System

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The ANOVA Procedure
Sediment 6
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	9042080275	3014026758	7.02	0.0162
Error	7	3006984827	429569261		
Corrected Total	10	12049065102			

R-Square	Coeff Var	Root MSE	sed Mean
0.750438	112.7807	20726.05	18377.30

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	9042080275	3014026758	7.02	0.0162

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	4.2957E8
Critical Value of t	0.71114
Least Significant Difference	12764
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	65196	3	Control
B	1016	3	Straw
B			
B	761	3	CBS
B			
B	617	2	50/50

The SAS System

The ANOVA Procedure
Sediment 7
Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	11
Number of Observations Used	11

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	330981689.8	110327229.9	7.95	0.0117
Error	7	97089623.0	13869946.1		
Corrected Total	10	428071312.8			

R-Square	Coeff Var	Root MSE	sed Mean
0.773193	101.7390	3724.238	3660.582

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	330981689.8	110327229.9	7.95	0.0117

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	13869946
Critical Value of t	0.71114
Least Significant Difference	2293.6
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	12618	3	Bare
B	399	3	Straw
B			
B	248	3	CBS
B			
B	237	2	50/50

The SAS System
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The ANOVA Procedure
Sediment 8
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System
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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	117597847.6	39199282.5	12.36	0.0035
Error	7	22205116.7	3172159.5		
Corrected Total	10	139802964.4			

R-Square	Coeff Var	Root MSE	sed Mean
0.841168	84.37187	1781.056	2110.959

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	117597847.6	39199282.5	12.36	0.0035

The SAS System
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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	3172160
Critical Value of t	0.71114
Least Significant Difference	1096.9
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	7450	3	Control
B	189	3	Straw
B			
B	64	3	CBS
B			
B	56	2	50/50

The SAS System

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The ANOVA Procedure
Sediment 9
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	66456223.68	22152074.56	10.21	0.0060
Error	7	15181272.20	2168753.17		
Corrected Total	10	81637495.88			

R-Square	Coeff Var	Root MSE	sed Mean
0.814040	91.98404	1472.669	1601.005

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	66456223.68	22152074.56	10.21	0.0060

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	2168753
Critical Value of t	0.71114
Least Significant Difference	906.97
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	5614	3	Control
B	157	3	Straw
B			
B	63	2	50/50
B			
B	57	3	CBS

The SAS System

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The ANOVA Procedure
Sediment 10
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read 11
Number of Observations Used 11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	40189421.19	13396473.73	7.12	0.0156
Error	7	13169536.87	1881362.41		
Corrected Total	10	53358958.07			

R-Square	Coeff Var	Root MSE	sed Mean
0.753190	102.4628	1371.628	1338.659

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	40189421.19	13396473.73	7.12	0.0156

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	1881362
Critical Value of t	0.71114
Least Significant Difference	844.74
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	4452	3	Control
B	377	3	Straw
B			
B	69	2	50/50
B			
B	33	3	CBS

The SAS System

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The ANOVA Procedure
Sediment 11
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System

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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	19632.98500	6544.32833	2.06	0.1942
Error	7	22241.65000	3177.37857		
Corrected Total	10	41874.63500			

R-Square	Coeff Var	Root MSE	sed Mean
0.468851	200.9563	56.36824	28.05000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	19632.98500	6544.32833	2.06	0.1942

The SAS System

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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	3177.379
Critical Value of t	0.71114
Least Significant Difference	34.715
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	97.03	3	Control
B	2.97	3	Straw
B			
B	2.05	2	50/50
B			
B	1.48	3	CBS

The SAS System
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The ANOVA Procedure
Sediment Total
Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	11
Number of Observations Used	11

The SAS System
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The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	90061100449	30020366816	31.31	0.0002
Error	7	6711739242	958819892		
Corrected Total	10	96772839691			

R-Square	Coeff Var	Root MSE	sed Mean
0.930644	48.47103	30964.82	63883.14

Source	DF	Anova SS	Mean Square	F Value	Pr > F
trt	3	90061100449	30020366816	31.31	0.0002

The SAS System
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The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.5
Error Degrees of Freedom	7
Error Mean Square	9.5882E8
Critical Value of t	0.71114
Least Significant Difference	19070
Harmonic Mean of Cell Sizes	2.666667

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	211641	3	Control
B	9109	3	CBS
B			
B	8422	3	Straw
B			
B	7599	2	50/50

The SAS System Runoff 8 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read 12
Number of Observations Used 12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	4513199690	902639938	2.60	0.1386
Error	6	2086899191	347816532		
Corrected Total	11	6600098881			

R-Square	Coeff Var	Root MSE	sed Mean
0.683808	99.49259	18649.84	18744.95

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	773401146	386700573	1.11	0.3884
trt	3	3739798544	1246599515	3.58	0.0859

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	3.4782E8
Critical Value of t	2.44691
Least Significant Difference	37260

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	48444	3	Bare
	A			
B	A	14854	3	Straw
B				
B		8708	3	CBS
B				
B		2974	3	50/50

The SAS System Runoff 9 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	138449853.2	27689970.6	2.31	0.1683
Error	6	71827630.1	11971271.7		
Corrected Total	11	210277483.3			

R-Square	Coeff Var	Root MSE	sed Mean
0.658415	64.94448	3459.953	5327.555

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	19094682.7	9547341.4	0.80	0.4930
trt	3	119355170.5	39785056.8	3.32	0.0982

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	11971272
Critical Value of t	2.44691
Least Significant Difference	6912.6

Means with the same letter are not significantly different.

t Grouping		Mean	N	trt
	A	10766	3	Bare
	A			
B	A	3918	3	Straw
B				
B		3540	3	CBS
B				
B		3086	3	50/50

The SAS System Runoff 10 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	12
Number of Observations Used	12

The SAS System

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	174325722.7	34865144.5	18.17	0.0015
Error	6	11512396.8	1918732.8		
Corrected Total	11	185838119.6			

R-Square	Coeff Var	Root MSE	sed Mean
0.938051	22.66544	1385.183	6111.434

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	3812277.1	1906138.6	0.99	0.4240
trt	3	170513445.6	56837815.2	29.62	0.0005

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	1918733
Critical Value of t	2.44691
Least Significant Difference	2767.5

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	12460	3	Bare
B	5334	3	Straw
B			
B	3778	3	50/50
B			
B	2874	3	CBS

The SAS System Runoff 11 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	227906.5883	45581.3177	0.82	0.5792
Error	6	335246.3966	55874.3994		
Corrected Total	11	563152.9849			

R-Square	Coeff Var	Root MSE	sed Mean
0.404697	33.92883	236.3777	696.6868

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	118425.4964	59212.7482	1.06	0.4035
trt	3	109481.0919	36493.6973	0.65	0.6096

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	55874.4
Critical Value of t	2.44691
Least Significant Difference	472.26

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	850.3	3	Bare
A			
A	695.5	3	Straw
A			
A	645.8	3	CBS
A			
A	595.2	3	50/50

The SAS System Runoff Total last 4 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 CBS Control Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	8309249492	1661849898	3.52	0.0787
Error	6	2833511207	472251868		
Corrected Total	11	11142760699			

R-Square	Coeff Var	Root MSE	sed Mean
0.745708	70.37213	21731.36	30880.63

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	1057317784	528658892	1.12	0.3862
trt	3	7251931708	2417310569	5.12	0.0431

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	4.7225E8
Critical Value of t	2.44691
Least Significant Difference	43417

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	72520	3	Control
B	24801	3	Straw
B			
B	15768	3	CBS
B			
B	10433	3	50/50

The SAS System Sediment 8 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 CMW Control Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	125604614.7	25120922.9	9.07	0.0091
Error	6	16615673.7	2769279.0		
Corrected Total	11	142220288.4			

R-Square	Coeff Var	Root MSE	sed Mean
0.883169	84.23198	1664.115	1975.633

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	5713341.2	2856670.6	1.03	0.4120
trt	3	119891273.5	39963757.8	14.43	0.0038

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	2769279
Critical Value of t	2.44691
Least Significant Difference	3324.7

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	7450	3	Control
B	200	3	50/50
B			
B	189	3	Straw
B			
B	64	3	CMW

The SAS System   Sediment 9 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 CMW Control Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	71681365.80	14336273.16	7.59	0.0142
Error	6	11326552.62	1887758.77		
Corrected Total	11	83007918.42			

R-Square	Coeff Var	Root MSE	sed Mean
0.863549	91.65138	1373.957	1499.113

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	3920932.59	1960466.30	1.04	0.4099
trt	3	67760433.20	22586811.07	11.96	0.0061

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	1887759
Critical Value of t	2.44691
Least Significant Difference	2745

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	5614	3	Control
B	168	3	50/50
B			
B	157	3	Straw
B			
B	57	3	CMW

The SAS System   Sediment 10 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 CMW Control Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	45107731.65	9021546.33	5.75	0.0275
Error	6	9420701.31	1570116.88		
Corrected Total	11	54528432.96			

R-Square	Coeff Var	Root MSE	sed Mean
0.827233	100.6838	1253.043	1244.533

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	3761925.58	1880962.79	1.20	0.3650
trt	3	41345806.07	13781935.36	8.78	0.0130

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	1570117
Critical Value of t	2.44691
Least Significant Difference	2503.4

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	4452	3	Control
B	377	3	Straw
B			
B	116	3	50/50
B			
B	33	3	CMW

The SAS System   Sediment 11 with plot 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 CMW Control Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	25833.84958	5166.76992	1.87	0.2345
Error	6	16609.12792	2768.18799		
Corrected Total	11	42442.97750			

R-Square	Coeff Var	Root MSE	sed Mean
0.608672	202.5547	52.61357	25.97500

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	5633.32875	2816.66438	1.02	0.4164
trt	3	20200.52083	6733.50694	2.43	0.1631

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	2768.188
Critical Value of t	2.44691
Least Significant Difference	105.12

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	97.03	3	Control
A			
A	2.97	3	Straw
A			
A	2.42	3	50/50
A			
A	1.48	3	CMW

The SAS System Sediment Total last 4 with 6

The ANOVA Procedure

Class Level Information

Class	Levels	Values
trt	4	50/50 Bare CBS Straw

Number of Observations Read	12
Number of Observations Used	12

The ANOVA Procedure

Dependent Variable: sed

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	700741569.5	140148313.9	8.21	0.0117
Error	6	102473226.3	17078871.1		
Corrected Total	11	803214795.8			

R-Square	Coeff Var	Root MSE	sed Mean
0.872421	87.09036	4132.659	4745.254

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	2	37942084.9	18971042.5	1.11	0.3887
trt	3	662799484.5	220933161.5	12.94	0.0050

The ANOVA Procedure

t Tests (LSD) for sed

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	17078871
Critical Value of t	2.44691
Least Significant Difference	8256.6

Means with the same letter are not significantly different.

t Grouping	Mean	N	trt
A	17613	3	Bare
B	726	3	Straw
B			
B	486	3	50/50
B			
B	156	3	CBS

Vita

Justin Fisher was born and raised in the hills of Tennessee where the western slope of the Cumberland Plateau meets the Eastern Highland Rim. Becoming an avid outdoor enthusiast he made the decision to pursue a career working with natural resources. He made the short hop east over the Cumberland's, into the Great Ridge and Valley, to continue his education at the University of Tennessee. A finer place to work outdoors and pursue a mastery of environmental science and natural resources would be hard for him to imagine. Ushered by many fine educators along the way, he has been very fortunate.